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SHARING THE EARTH

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ISIS

INDIVIDUALIZED SCIENCE INSTRUCTIONAL SYSTEM

SHARING THE EARTH

ANNOTATED TEACHER'S EDITION

Ginn and Company

The work presented or reported herein was supported by a grant from the National Science Foundation. However, the opinions expressed herein do not necessarily reflect the position or policy of the National Science Foundation, and no official endorsement by that agency should be inferred.

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ANNOTATED TEACHER'S EDITION

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OVERVIEW

Sharing the Earth explores the ecological relationships of biological communities through topics such as abiotic conditions, adaptation and natural selection, food webs, succession, and competition. The *Community Atlas*, an atlas of principal biological communities, allows students to apply their knowledge to populations and conditions found in their local section of the contiguous United States. The effects of human activities on natural populations is given special attention.

ORGANIZATION

Sharing the Earth contains ten core activities, four advanced activities, and three excursion activities. The first activity in each section is a planning activity and should be done before any of the other activities in that section. Students who plan to do Activity 2 should do it after Activity 1 but before the other core activities. The other activities may be done in any order. Activity 10 is a required activity and should be done by all students.

Activities 12 and 16 both require a period of time for plant development. You may want to encourage students to begin those two activities early in the minicourse schedule.

In the core activities, students become familiar with the biological communities of their section of the contiguous United States. They observe the response of a local organism to abiotic conditions and use local examples to learn about food chains and webs, the cycles of water, carbon, nitrogen, and oxygen, and natural selection. At some point, students are expected to visit a local community to see as much as they can firsthand. Predator–prey relationships are explored, including the ways people affect these relationships by hunting and by game-control techniques. The effects of land clearing and construction on local populations are also treated.

Advanced activities give students the opportunity to design and conduct an experiment to test the effects of certain abiotic conditions upon radish seed germination. They also learn about food pyramids and the stages of plant succession.

In the excursions, students can see the effects of competition upon radish seedlings and discover the importance of fire to the propagation of the Ocala sand pine.

Accompanying *Sharing the Earth* is the *Community Atlas*. It contains the following:

1. A map dividing the continental United States into eight local sections. The map is keyed to distinguish the local communities within each section.

2. Panoramic art of each of the eight types of ecological communities. The accompanying text describes each community's special physical and biological features and food relationships. It also cites an example of environmental adaptation.

3. Maps showing U.S. patterns of sunshine, rainfall, temperature, and climatological zonation.

4. A glossary of technical and semitechnical words and phrases encountered in the minicourse.

MATERIALS AND EQUIPMENT

The following tables show the quantity and the frequency of use of each item used in each activity. The activities that require no materials are not listed in the tables.

It is important to collect and organize all the materials for each minicourse before the students begin any of the activities, since the students will be working simultaneously on different activities. Having all materials readily available allows students to do the activities in the order they choose. The amount of materials you will need to make available will depend on the number of lab groups that will be doing each activity. As lab groups use the "skipping option" and as they scatter themselves throughout the activities, the total amount of materials needed at one time for each activity will decrease.

CONSUMABLE ITEMS	MINIMUM MATERIALS PER LAB GROUP† PER ACTIVITY					
	3	5	9	12	16	17
*Crossword puzzles duplicated from pages 10 and 11 (optional)	1					
Match, safety						2
*Milk jug, large, plastic			2			
Paper, white, notebook sheet		1				
*Pine cone, Ocala sand						1
Plastic wrap, 30 cm × 60 cm piece			1			
Seed, radish				30	100	
Soil, potting (g)					150	
String, on spool (m)		2.5				
Tape, masking, 2 cm × 60 cm piece			1			
Towel, paper				2		
Water, cold (l)			2			
Water, distilled, in dropping bottle (ml)				25		
Water, hot (l)			2			

*See "Advance Preparations."

†A *lab group* is defined as one student, a pair of students, or any size group of students that you choose.

NONCONSUMABLE ITEMS	MINIMUM MATERIALS PER LAB GROUP† PER ACTIVITY											
	1	2	3	4	5	7	8	9	10	12	16	17
*Animal, small (earthworm, mealworm, or sow bug; all of same kind)								6				
*Bag, plastic, clear										2		
*Bag, plastic, heavy, dark										3		
Beaker, 600 ml												1
Box, small shoe, with lid										3		
Burner, Bunsen												1
Camera (optional)									1			
*Carpet, deep pile, green, about 1 m × 1 m				1								
*Choice chamber consisting of								1				
box, clear plastic, 5 cm × 10 cm × 30 cm								1				
cardboard, piece 5 cm × 10 cm								1				
*Cloth, black, 30 cm × 60 cm								1				
Community Atlas	1	1	1		1				1			
Field glasses (optional)									1			
*Food-web board made from					1							
plywood, 1 cm × 25 cm × 30 cm					1							
nail, finishing					9							
Graduated cylinder, 50 ml										1		
Grease pencil										1	1	
Hand lens (optional)									1			
*Incubator										1		
Jar, baby food										3		
*Lamp, 150 watt										1	1	
Metre stick				1								
Pot, flower, small, or plastic cup											3	
*Refrigerator										1		
Ring stand												1
Ring for ring stand												2
Ruler, metric											1	
Safety goggles												1
Scissors					1			1				
*Thermometer, Celsius								1		1		
*Toothpick, green				100								
*Toothpick, red				100								
Tray, 15 cm × 30 cm × 2 cm, or milk carton cut in half lengthwise											1	
Watch or clock with second hand				1								
Wire, bare copper (cm)												20
Wire, gauze, asbestos (for ring stand)												1
Resource Unit 1											1	
Resource Unit 2						1	1					
Resource Unit 4							1				1	
Resource Unit 5										1		
Resource Unit 14								1				
Resource Unit 15								1		1		
Resource Unit 17												1

*See "Advance Preparations."

†A *lab group* is defined as one student, a pair of students, or any size group of students that you choose.

Activity 3

If you wish, the crossword puzzles on pages 10 and 11 can be duplicated ahead of time and given to students as they need them.

Activity 4

Plain wooden toothpicks can be easily dyed by submerging them in a strong solution of food coloring or water colors and water until the color penetrates the wood. Then remove them, and allow them to dry.

The best setting, by far, for the investigation is an area of green grass. If at all possible, reserve a healthy plot, 2 m X 2 m, near the school building. If the grass and green toothpicks are well matched, the demonstration will be quite impressive. Some "moths" will be lost ("saved") permanently. If grass is not available, select one of the two options below.

Option 1

Get a piece of deep pile, green carpet about a metre square. Match its color with one of the sets of toothpicks. Put it in an isolated area of the classroom for students to use.

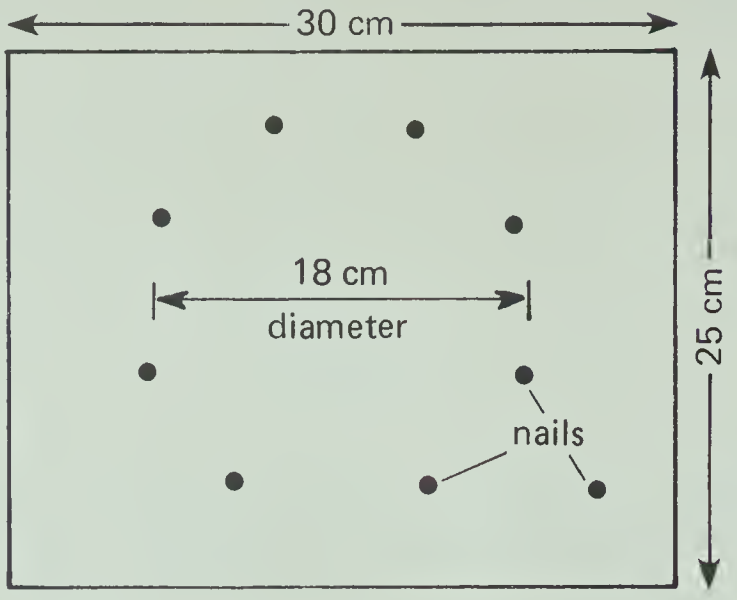
Option 2

Lay down a large square of posterboard. Instead of toothpicks, use "moths" cut from the same posterboard and others cut from posterboard of a contrasting color. Protect the background board by covering it with contact paper of clear plastic. The "moths" can be cut moth-shaped or just as 2-cm or 3-cm squares. Have students sprinkle the "moths" on the board and then see how many can be "captured" one-handed in the allotted time.

Activity 5

Prepare the food-web board as follows. Get a piece of wood 1 cm thick. Cut it to measure 25 cm X 30 cm. Put eight finishing

nails in a circle 18 cm in diameter and one nail in the lower right corner. See the diagram below.



An alternative procedure is to let nine students, each representing one of the eight organisms or the sun, stand in a circle. They pass the ball of string back and forth as described for the board. Then they answer the questions together.

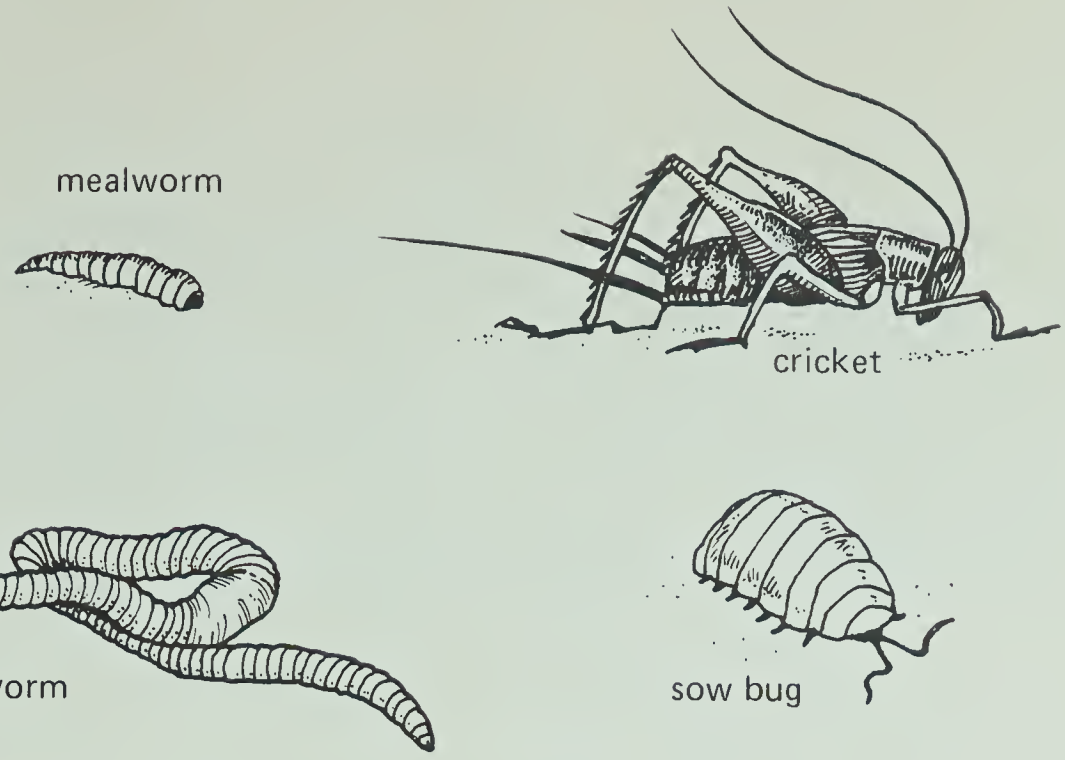
Activity 8

The following are three excellent resources about whales. You may wish to have them available in the classroom for students who want additional information:

Audubon. 77 (January 1975): entire issue.
Graves, William. "The Imperial Giants." *National Geographic* 150 (December 1976): 722-51.
Scheffer, Victor B. "Exploring the Lives of Whales." *National Geographic* 150 (December 1976): 752-66.

Activity 9

You'll need to get some small animals such as earthworms, crickets, mealworms, or sow bugs. Earthworms, crickets, and mealworms may be purchased at pet shops or bait shops. During warm seasons of the year, earthworms and sow bugs may be found in garden soil or near foundations of buildings. Large numbers of sow bugs may be attracted by placing a piece of freshly cut potato, with the cut side down, on the surface of the soil near a basement wall or foundation where a few have been seen.



The activity will not harm the animals, which may be released after the class investigations. Be sure to provide a rest container for them so that students don't continue to use the same animals repeatedly.

You can maintain the animals in the classroom for the few days they are needed. Put mealworms in bran, adding small pieces of apple for food. Earthworms, crickets, and sow bugs will do fine in a container in which moist soil is covered with plant matter, shredded leaves, roots, stems, blades of grass, or straw. For further advice, consult Behringer or Morholt et al. in "References."

The choice chamber should be made from a rectangular plastic box with a clear lid. Such boxes are widely available at hardware and variety stores. Be sure they are at least 30 cm long and not too wide. Get a piece of smooth (not corrugated) cardboard. Cut the cardboard to shape for a center divider, leaving a doorway large enough to accommodate at least one animal. Tape the divider in place, if necessary.

The supports for the chamber can be cut plastic milk jugs. The hollows of the supports can then be filled with hot or cold water at the appropriate point in the investigation.

Activity 10

Field trips may be taken by individuals, groups, or the class, as circumstances dictate. Behringer and Horholt et al. in "References" offer tips on planning and collecting. Unless you have definite plans for them, leave all encountered organisms in their natural habitats. It's a laudable example for students.

Activity 12

Four days must elapse from the beginning of this activity until the recording of data on seed germination. Plan for that. It's best to start on either Monday, Tuesday, or Friday.

Testing for temperature will usually entail a refrigerator and an incubator. The latter can be rigged with a lamp inside an asbestos-lined box. But be careful — overheating can cause fires! Depending on available equipment, students may have to make modifications in the experimental design.

Activity 16

Students should begin this activity early in the minicourse to allow time — about eight to fourteen days — for plant growth. Growing time varies considerably depending upon conditions. Students are told to prepare to collect data for fourteen days, but they may not need that much time. As soon as the plants reach an acceptable height, you may want to tell them to proceed with their conclusions.

If flower pots are not available, plastic foam cups may be used instead.

Activity 17

Cones of the Ocala sand pine, *Pinus clausa*, when brown and mature, open only in response to heat. Although several other species of pine are serotinous and have late-opening cones, their cones will open for reasons other than heat. Futhermore, a closed cone may have opened, scattered its seeds, and closed again. Thus its opening in response to heat will produce few or no seeds.

The following table lists the cones in various sections of the United States that are adequate substitutes for the Ocala sand pine cone — provided they have not opened naturally already. The Ocala sand pine is native to the central and northern gulf areas of Florida.

ALTERNATIVES TO THE OCALA SAND PINE CONE		
Common Name	Scientific Name	Where Commonly Found
Jack pine	*Pinus banksiana*	Northern lake country, Maine westward to Minnesota
Lodgepole pine	*Pinus contorta*	Northwest from Colorado to Pacific coast
Pond pine	*Pinus serotina*	Southeast from Delaware along east coast to Florida gulf coast
Pitch pine	*Pinus rigida*	Appalachian Mountains from Maine to northern Georgia
Monterey pine	*Pinus radiata*	California coast (partially serotinous)

For more information on pine-tree reproduction, reforestation, and the effects of fire on pine-seed dispersal, contact the local office of the U.S. Forest Service. Forest Service personnel may be helpful in locating suitable cones. See also *Silvics of Forest Trees of the United States*. Agricultural Handbook No. 271. Washington, D.C.: U.S. Department of Agriculture, 1965.

BACKGROUND INFORMATION

The organization of the *Community Atlas* may convey the impression that the contiguous United States consists of a small variety of clearly defined ecological communities. This is by no means true. Intermediate, graded, or blended zones appear in numerous ecotone areas. The field trip in Activity 10 may well demonstrate this.

Limitations of space and considerations of simplicity preclude discussion of many interesting points of similarity among communities, and many points of contrast also. More helpful than any generalizations here will be the handbooks and ecological reference books of your locality.

Checklists and keys to local fauna and flora are usually invaluable aids. Check with the biological taxonomists at your state university. The Time-Life American Wilderness Series may be very helpful, as may the publications of state and federal agencies.

A state-by-state listing of endangered species of plants and animals is available from

National Wildlife Federation
1412 Sixteenth Street, N.W.
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Safety Contracts

ISIS strongly recommends that all students sign a safety contract early in the school year before beginning any minicourse. A sample safety contract can be found in *Managing ISIS.*

To help reinforce the provisions of the safety contract, ISIS has placed various cautionary notes in the student's book. You will note that these cautions emphasize eye safety in particular.

Eye Safety

ISIS recommends that students wear safety goggles whenever they are working in a laboratory situation. Although a particular student may not be working with hazardous materials, other students nearby may be.

EVALUATION SUGGESTIONS

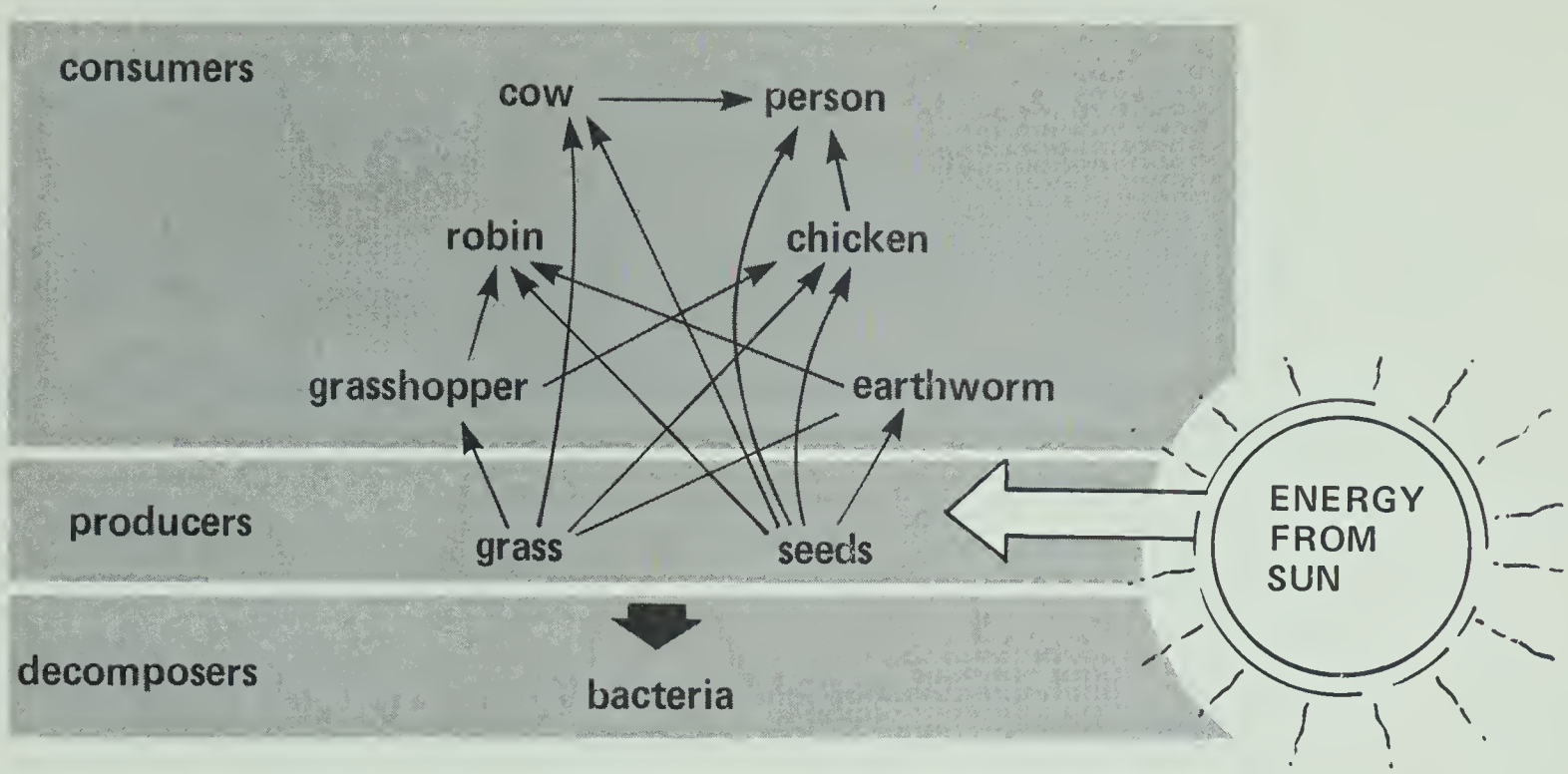
In addition to the *Minicourse Test,* answers to which are provided with the test, you may want to use the following essay questions.

Essay Questions

Four essay questions are included here with model answers for your convenience. The first three essay questions are based on core materials. The fourth questions deals with materials found in the advanced section.

1. Construct a food web using these organisms:
Person — eats chicken, beef, seeds
Grass — makes own food
Grasshopper — eats grass
Robin — eats earthworms, seeds, grasshoppers
Cow — eats grass, seeds
Chicken — eats grasshoppers, grass, seeds
Earthworm — eats grass, seeds
Seeds — produced by plants that make their own food
Bacteria — eat dead or decaying matter
Place each organism on the level of decomposers, consumers, or producers.

Answer: The web should be similar to the one shown below.



2. Describe some of the ways that plants exchange or recycle materials in their environment.

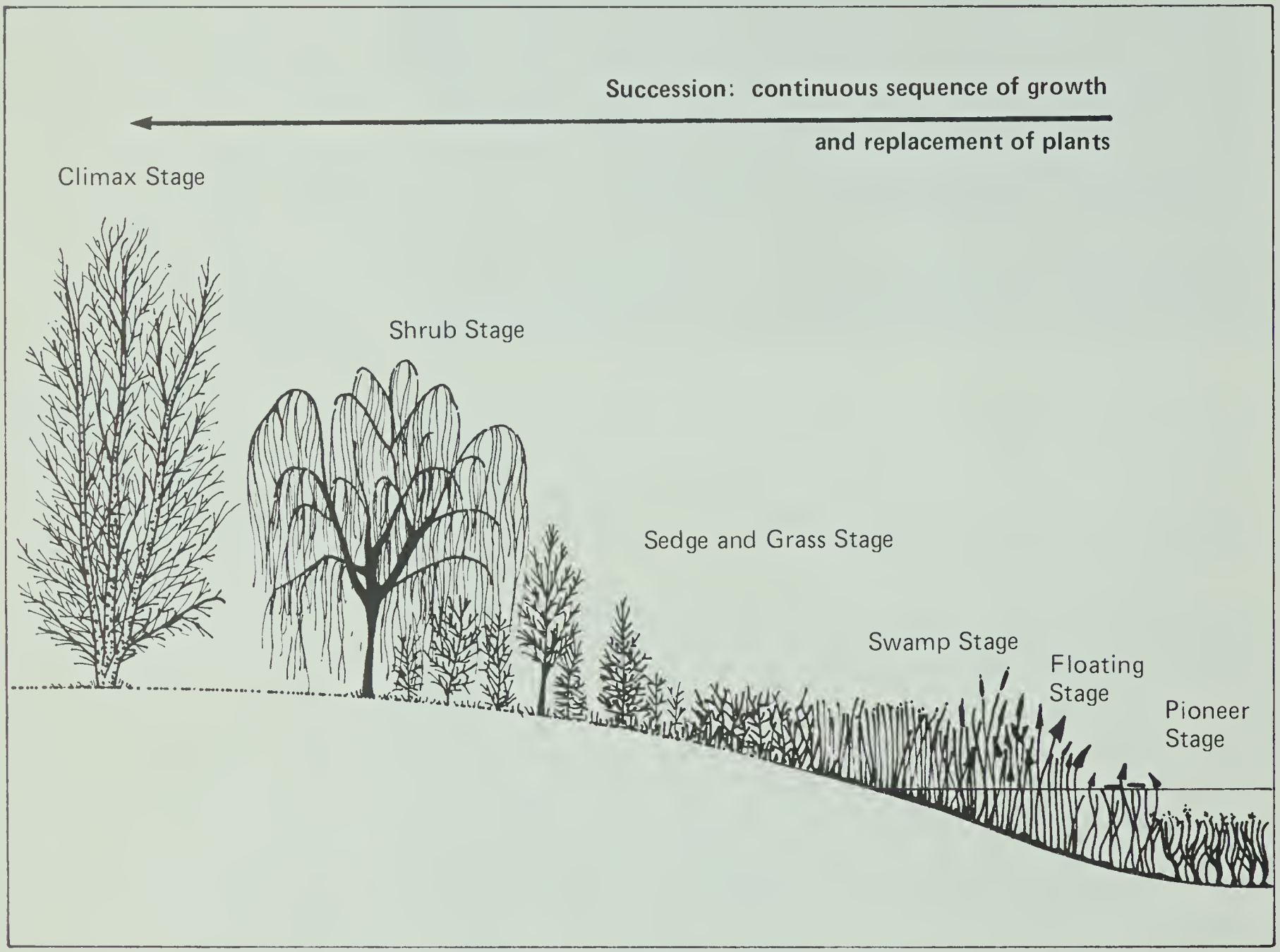
Answer: During the process of photosynthesis, a plant uses carbon dioxide from the air and releases oxygen. Plants also release some water into the atmosphere. Roots take up water and minerals, which are used in the process of producing new plant tissue. When the leaves fall or when the plants die, they are decomposed and returned to or recycled in the soil. Green plants convert light (radiant energy) from the sun into chemical energy, which they store as carbohydrates (sugars and starches). First-level consumers eat the plants and use the stored energy (carbohydrates).

3. Define the term *population*, and list possible changes that can happen to a population as time passes.

Answer: A *population* can be defined as "a given number of organisms of a given species living in one area at one time." A population can increase in size, decrease in size, become extinct, or become and remain stable.

4. Describe the stages of forest succession, beginning with a lake.

Answer: As the lake fills with sediments and becomes shallower, plants that occurred near the shore gradually establish themselves closer and closer to the center of the lake. Ultimately, grasses, woody shrubs, and trees of the surrounding climax forest completely replace the aquatic plants.



REFERENCES

Atkin, J.M.; Gallant, Roy A.; and Asimov, Isaac. *Ginn Science Program — Advanced Levels A and B.* Lexington, Massachusetts: Ginn and Co., 1973.

Units 1, 7, and 8 in Level A and Unit 7 of Level B treat ecological concepts included in this minicourse. The reading level is junior high school.

Barnett, J.P., and McLeMore, B.F. *Cone and Seed Characteristics of Sand Pine.* U.S. Forest Service Research Paper SO-19, 1965.
This describes the various features of Ocala and Choctawhatchee sand pines, including their fire-caused seed dispersal trait.

Behringer, Marjorie P. *Techniques and Materials in Biology.* New York: McGraw-Hill, Inc., 1973.
This is a source book for techniques in the teaching of the biological sciences.

Biological Sciences Curriculum Study. *Biological Science: An Inquiry into Life.* 3rd ed. New York: Harcourt Brace Jovanovich, Inc., 1973.
The first three parts explore some of the ecological concepts included in this minicourse. Sections of the Teacher's Edition may be helpful too.

Engel, Leonard, and the Editors of Time-Life Books. *The Sea.* New York: Time, Inc., 1969.
See especially the sections pertaining to saltwater organisms and food webs. The book contains many illustrations.

Farb, Peter, and the Editors of Time-Life Books. *Ecology.* New York: Time, Inc., 1970.
Basic ecological concepts are discussed, using examples and many color photographs. Students and teachers alike can benefit.

_____. *The Forest.* New York: Time, Inc., 1963.
The authors present an overview of the forest ecosystem and the complexities of its plant and animal life. This is a source book for teachers and students.

Kendeigh, S. Charles. *Ecology with Special Reference to Animals and Man.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1974.
For the teacher and advanced students, this comprehensive book treats the ecological adjustments of animals and people, with sections on pollution, population growth, energy yield, and pest control, among others.

Leopold, A.S., and the Editors of Time-Life Books. *The Desert.* New York: Time, Inc., 1961.

This reference for students and teachers uses many photographs in describing the physical and biotic conditions and adaptations to life in this harsh environment.

Miller, H.A., and Jaques, H.E. *How to Know the Trees.* 2nd ed. Dubuque, Iowa: W.C. Brown Company, 1972.

This is a good source for teachers for local tree identification. The serotinous pines are fully described.

Milne, Jorus J.; Milne, Margery; and the Editors of Time-Life Books. *The Mountains.* New York: Time, Inc., 1971.

The sections on mountain plants and animals are especially pertinent.

Morholt, Evelyn; Brandwein, Paul F.; and Joseph, Alexander. *Teaching High School Science: A Sourcebook for the Biological Sciences.* New York: Harcourt Brace Jovanovich, Inc., 1966.

This source book gives information and techniques necessary for the teaching of the biological sciences.

Smith, Robert L. *Ecology and Field Biology.* 2nd ed. New York: Harper & Row, Publishers, 1974.

Here is basic ecological information for the teacher and advanced students with informative illustrations, tables, graphs, and photographs.

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In addition to the major effort by the ISIS permanent staff, writing conference participants, and author-consultants (listed on the inside of the back cover), the following contributed to this minicourse.

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Special consultant: Ted F. Andrews, University Professor of Life Science and Dean of the College of Environmental and Applied Science, Governors State University, Park Forest South, Illinois

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Foreword

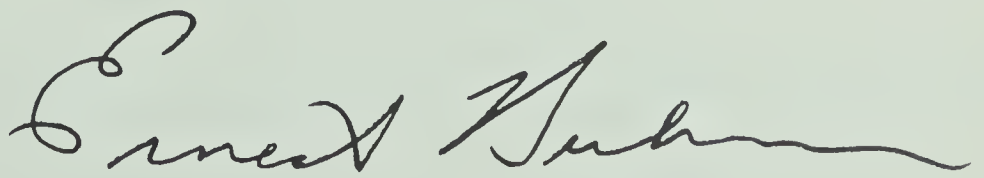
Evidence has been mounting that something is missing from secondary science teaching. More and more, students are rejecting science courses and turning to subjects that they consider to be more practical or significant. Numerous high school science teachers have concluded that what they are now teaching is appropriate for only a limited number of their students.

As their concern has mounted, many science teachers have tried to find instructional materials that encompass more appropriate content and that allow them to work individually with students who have different needs and talents. For the most part, this search has been frustrating because presently such materials are difficult, if not impossible, to find.

The Individualized Science Instructional System (ISIS) project was organized to produce an alternative for those teachers who are dissatisfied with current secondary science textbooks. Consequently, the content of the ISIS materials is unconventional as is the individualized teaching method that is built into them. In contrast with many current science texts which aim to "cover science," ISIS has tried to be selective and to limit our coverage to the topics that we judge will be most useful to today's students.

Obviously the needs and problems of individual schools and students vary widely. To accommodate the differences, ISIS decided against producing tightly structured, pre-sequenced textbooks. Instead, we are generating short, self-contained modules that cover a wide range of topics. The modules can be clustered into many types of courses, and we hope that teachers and administrators will uhilize this flexibility to tailor-make curricula that are responsive to local needs and conditions.

ISIS is a cooperative effort involving many individuals and agencies. More than 75 scientists and educators have helped to generate the materials, and hundreds of teachers and thousands of students have been involved in the project's nationwide testing program. All of the ISIS endeavors have been supported by generous grants from the National Science Foundation. We hope that ISIS users will conclude that these large investments of time, money, and effort have been worthwhile.



Ernest Burkman
ISIS Project
Tallahassee, Florida

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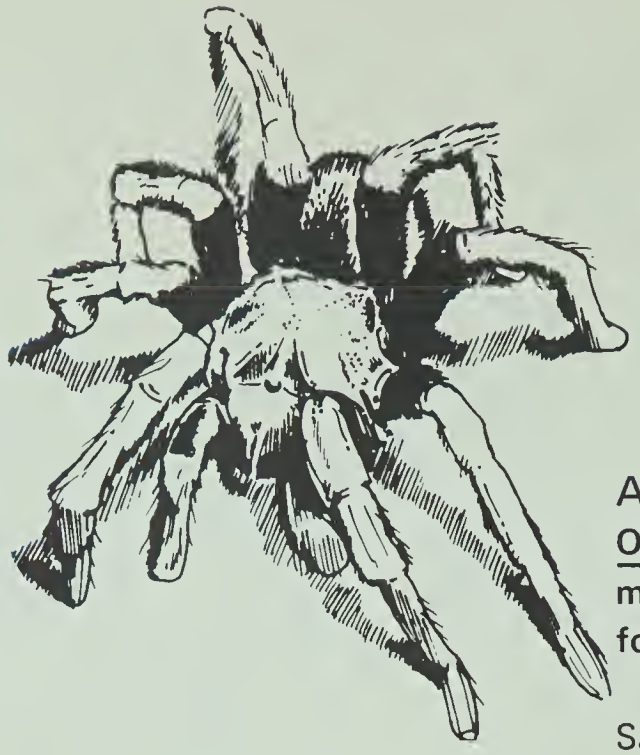
WHAT'S IT ALL ABOUT?

Living things are everywhere. They are found in every possible place on Earth — on the ocean floor, under the snows of the antarctic, in burrows on the desert, and between the walls of your home.

No matter where plants and animals live, they are affected by their surroundings. In this minicourse, you'll learn some of the ways plants and animals interact with each other and their environment. You'll also learn of some ways people have changed Earth to suit their own needs — not always to the benefit of other living things.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter.

Have your students read the excursion planning activity (Activity 15) as soon as they finish Activity 1. Ask them to decide whether they want to do Activity 16. Any students who choose to do Activity 16 should begin it immediately, since it can take up to two weeks to complete.



Core

ACTIVITY 1: PLANNING

If you plan to do Activity 2, do it before you do any of the other core activities.

The other core activities may be done in any order. Activity 10 is required. Be sure to do it.

Get the *Community Atlas* that goes with this minicourse. The *Atlas* describes the main types of ecological communities in the United States. Open the *Atlas* to Plate 1. Notice that the map in Plate 1 divides the United States into eight *local sections*. Find your own local section — the one where your school is.

Plate 1 also shows the distribution of the seven types of *local communities*. Check the key, and determine which types are found in your local section. Suppose, for example, that your school is in Atlanta. That's Local Section 2. From the key, you can see that seven of the eight local community types occur in your section (all but the desert community).

The terms *local section* and *local community* will appear throughout this minicourse. They'll always be used in the way described above.

Activity 2 Page 5

Objective 2-1: Tell what ecological communities are, and list the main types found in your local section.

Sample Question: An ecological community is mainly defined by the type and number of animals living in it.

A. True
B. False

Objective 2-2: Describe the main physical and biological features of the communities in your local section.

Sample Question: What are two physical features of a forest community?

A. The trees are leafless in winter.
B. At ground level, the light is dim.
C. There are lots of shrubs and weeds.
D. Rainfall is high.

Activity 3 Page 8

Objective 3-1: Give examples from your local section of how plants and animals are adapted to physical features of their communities.

Sample Question: What is one way that snails are adapted to the movement of water in a moving freshwater community?

A. They drift with the current.
B. They attach themselves permanently to the bottom and grow there.
C. They hold onto solid surfaces with their sticky foot.
D. They swim to still water.

Activity 4 — Page 12

Objective 4-1: Explain the distribution of light and dark peppered moths in terms of natural selection.

Sample Question: Why do more dark peppered moths than light peppered moths occur near industries?

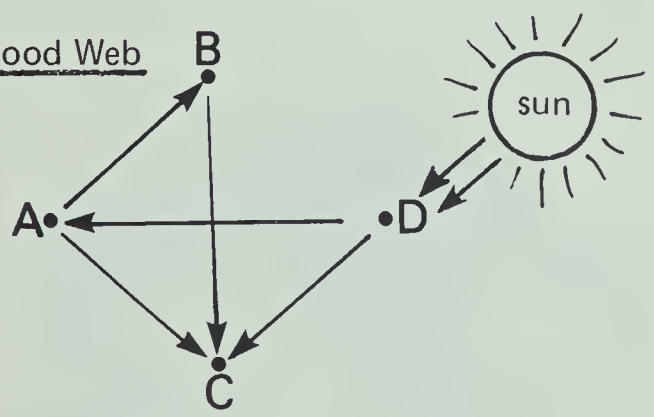
A. Birds often don't see dark peppered moths against tree bark that's been dirtied by smoke. Thus, the birds don't eat the dark moths.
B. Dark peppered moths rest only on dark tree bark.
C. Light peppered moths on dirty tree bark are easily seen by birds. Thus, the birds eat the light moths.
D. A light peppered moth can turn dark to match the color of the tree bark.

Activity 5 — Page 18

Objective 5-1: Diagram a biological food web or chain, using principal local plants and animals.

Sample Question: The organisms listed below are four of the many members of an urban food web. Match the number of each organism to its letter in the diagram of the simple food web.

Food Web



Organisms

1. robin (eats insects)
2. caterpillar (eats leaves)
3. plant leaves (make own food)
4. bacteria (use dead or decaying matter for food)

Activity 6 — Page 25

Objective 6-1: Tell how water, carbon, nitrogen, and oxygen are recycled naturally.

Sample Question: What are the four main steps of the water cycle?

Activity 7 — Page 29

Objective 7-1: Identify and evaluate five common methods used by the government to control the size of wildlife populations.

Sample Question: Tell whether the following statement is true or false. Unrestricted hunting has proved to be the best single method for managing animal populations.

Objective 7-2: Describe what unexpectedly happened when predator removal was used to control the size of deer populations.

Sample Question: When the Kaibab deer-population's predators were removed, what were the unexpected side effects?

A. Food supplies in the area decreased after a while.
B. Mammals such as rabbits, normally killed by predators, increased in number.
C. The number of predators increased because there was more food for them.
D. The number of deer first decreased, then increased as the rabbits and insects died.

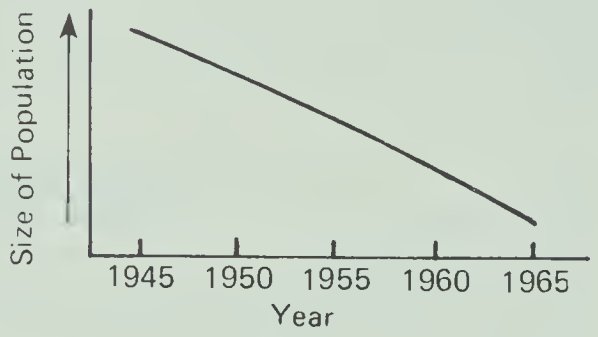
Answers: **2-1.** B; **2-2.** B, D; **3-1.** C; **4-1.** A, C; **5-1.** A2, B1, C4, D3; **6-1.** precipitation, above-ground flow, underground flow, and evaporation; **7-1.** false; **7-2.** A, B

Activity 8 Page 35

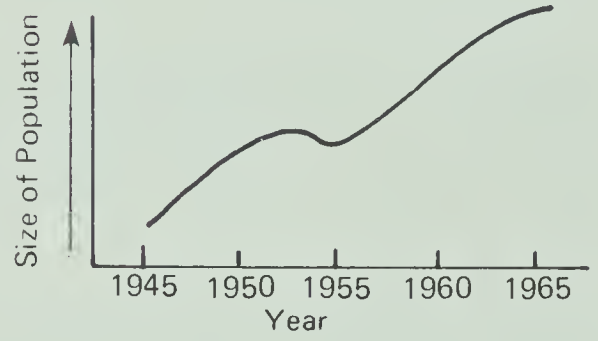
Objective 8-1: Interpret graphs of recent trends in the size of wildlife populations killed for human use.

Sample Question: Blue whales were hunted and killed between 1945 and 1966. Very few are left now. Which of the graphs below shows that trend?

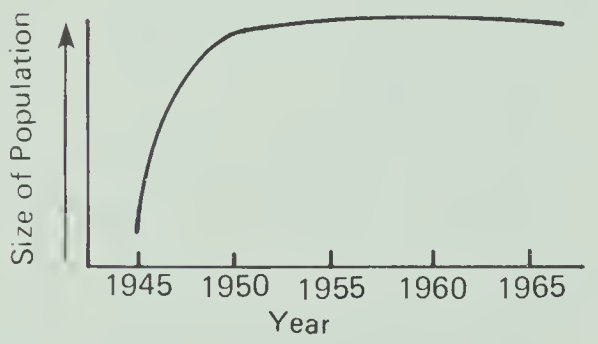
A.



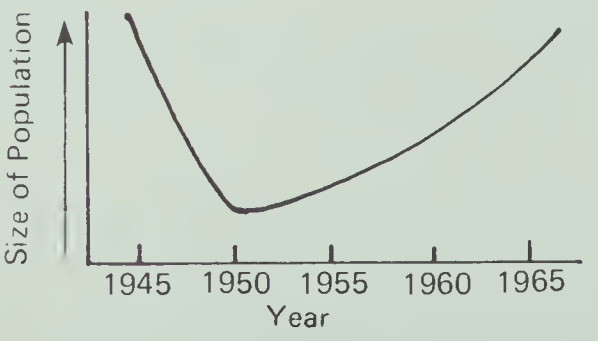
B.



C.



D.



Activity 9 Page 39

Objective 9-1: Identify the effects on natural communities, food supplies, and population sizes of such actions as land clearing and the building of dams in drainage basins.

Sample Question: When land is cleared and new homes are built,

A. natural food supplies decrease.
B. natural food supplies increase.
C. nearby wildlife populations decrease in size.
D. natural communities are destroyed.

Activity 10 Page 47

Required Activity: This activity gives you the opportunity to study a local community firsthand.

Answers: 8-1. A; **9-1.** A, D

ACTIVITY 2: ECOLOGICAL COMMUNITIES AROUND YOU

In Activity 1, you looked at the *Community Atlas* that accompanies this minicourse. Get the *Atlas* again, and open it to Plate 1. Notice again that the U.S. map is divided into eight sections. Your *local section* is the one where your school is located. Find the number of your local section on the map.

- 2-1. What's the number of your local section?

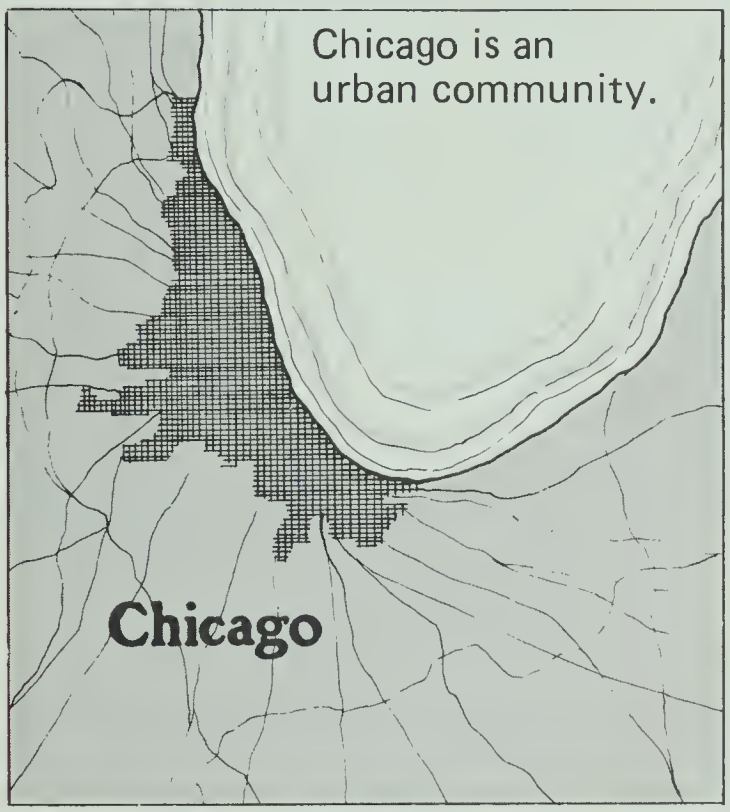
The map in Plate 1 also shows the eight major types of *ecological communities* found in the adjoining forty-eight states. Each community is a group of living things sharing a common location in the environment.

ACTIVITY EMPHASIS: There are eight types of ecological communities in the eight sections of the contiguous United States. They are defined by abiotic and biotic factors.

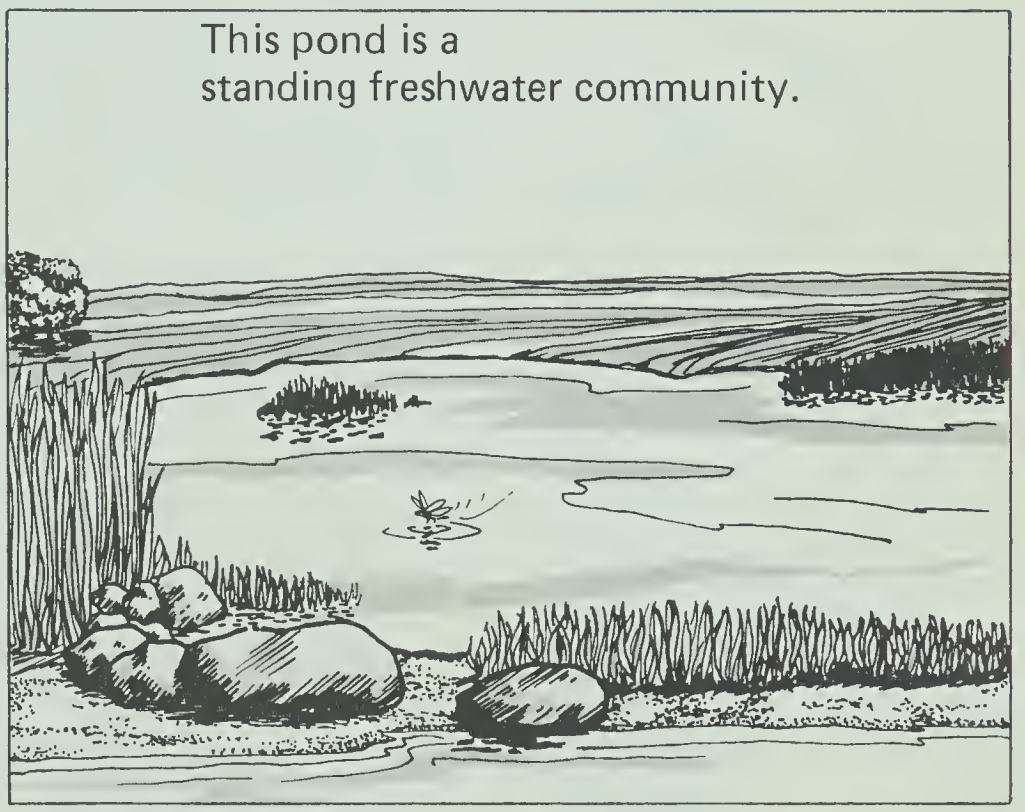
MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter.

2-1. [Answers will vary.]

2-2. A group of living things that share a common location



All the birds, people, trees, ants, dogs, grass, flowers, and so on live together here.



All the fishes, snails, birds, beavers, pond lilies, cattails, and so on live together here.

☆ **2-2. What is an ecological community?**

Using the map key on Plate 1, decide which ecological communities occur in your local section.

☆ **2-3. List the types of communities in your local section of the country.**

- 2-4. Which four community types occur in all eight local sections?

2-3. [Answers will vary, but they should be consistent with the following: Section 1 has all but grassland and desert; Sections 2 and 3 have all but desert; Section 4 lacks desert, seacoast, and coastal wetlands; Section 5 lacks seacoast and coastal wetlands; Sections 6, 7, and 8 have all community types.]

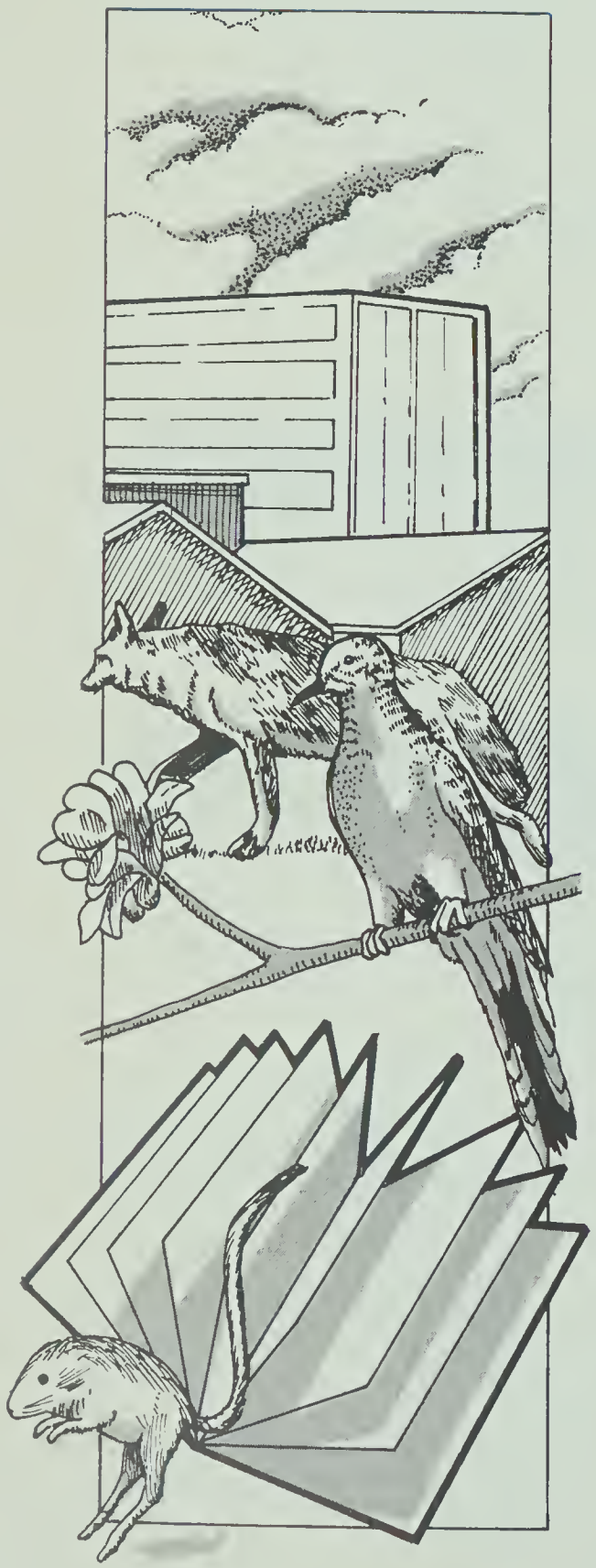
2-4. Forest, urban, moving freshwater, and standing freshwater communities

2-5. Biological features and physical features

2-6. Trees; rich, acid soil, moderate to heavy rainfall, and pattern of sun above and shade below

2-7. There is an interrelationship between biological and physical features.

2-8. All occur — most more than once



The eight types of communities are quite different from one another. Each has its own unique special features. These features can help you recognize the various ecological communities located near you.

● 2-5. Turn in the *Atlas* to "Plate 2. Forest Community." Look at the section called "Special Features" at the bottom of the left-hand page. What two types of features are listed?

Each environmental community has certain biological and physical features. The most important physical features are listed with a check (√) before them. The biological feature of *dominance* is particularly significant. The dominant life form is the most common or visible living part of the community. It strongly affects all the other living things.

A community is often recognized, though, by its physical features. These are things like water, light, wind, temperature, and soil. They combine to make up the physical surroundings of the area.

● 2-6. Look at Plate 2 of the *Community Atlas*. What is the dominant life form or forms in the forest? What are the three main physical features?

● 2-7. Not all plants and animals live together in a single community such as the forest. Only certain kinds are found together. Why do you think that is?

Now look carefully at all of the community plates (Plates 2 through 9) in the *Community Atlas*. Look at each scene, and read the "Special Features" section of each plate. Then answer Questions 2-8 through 2-11 below and on page 7.

● 2-8. Which of the following physical features are found in at least one of the eight community types illustrated in the *Community Atlas*?

A. Water (precipitation, oxygen availability, evaporation, pollution, salt-mineral concentration, waves, tides, and undercurrents)
B. Temperature (hot, moderate, or cold)
C. Light (bright, shady, or dark)
D. Air (polluted, windy, humid, and so on)
E. Artificial structures (buildings, streets, lights, bridges, boats, and so on)
F. Soil (acid, alkaline, moist, dry, and so on)
G. Wind (calm, light breeze, heavy breeze, hurricane)

The "Glossary of Terms" on Plate 10 in the *Community Atlas* should be very helpful to you as you're doing this mini-course. But if a troublesome word isn't there, use your dictionary.

☆ 2-9. Match the dominant life forms with their communities. Do only those that are found in your local section of the United States. (Answers may be used more than once.)

Community	Dominant Life Form
A. Coastal wetlands	1. people
B. Forest	2. grasses
C. Grassland	3. trees
D. Standing fresh water	4. no dominant life form
E. Urban areas	

2-9. A4, B3, C2, D4, E1

☆ 2-10. Describe two biological features of the moving freshwater community.

2-10. Many plants and animals; few large plants and animals

☆ 2-11. Match the following physical features with their communities. Do only those found in your local section of the United States.

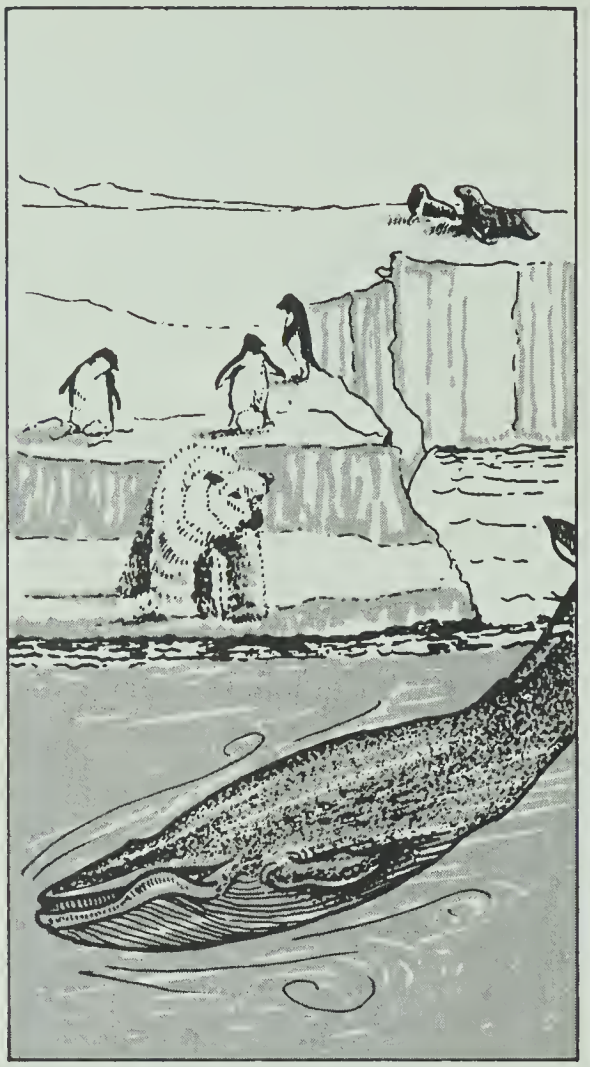
Physical Features	Community
A. Bottom covered with large rocks or hard clay; lots of oxygen available in water	1. seashore
B. Little water; high evaporation; large temperature difference from day to night	2. moving fresh water
C. Dim light on ground; moderate to heavy rainfall; rich soil	3. urban area
D. Bottom covered with decaying material and sediments; some oxygen available in water	4. standing fresh water
E. High salt-mineral concentration; constant wave action; little shade	5. forest
F. Soil often covered by buildings; artifical light at night; air and water often polluted	6. desert

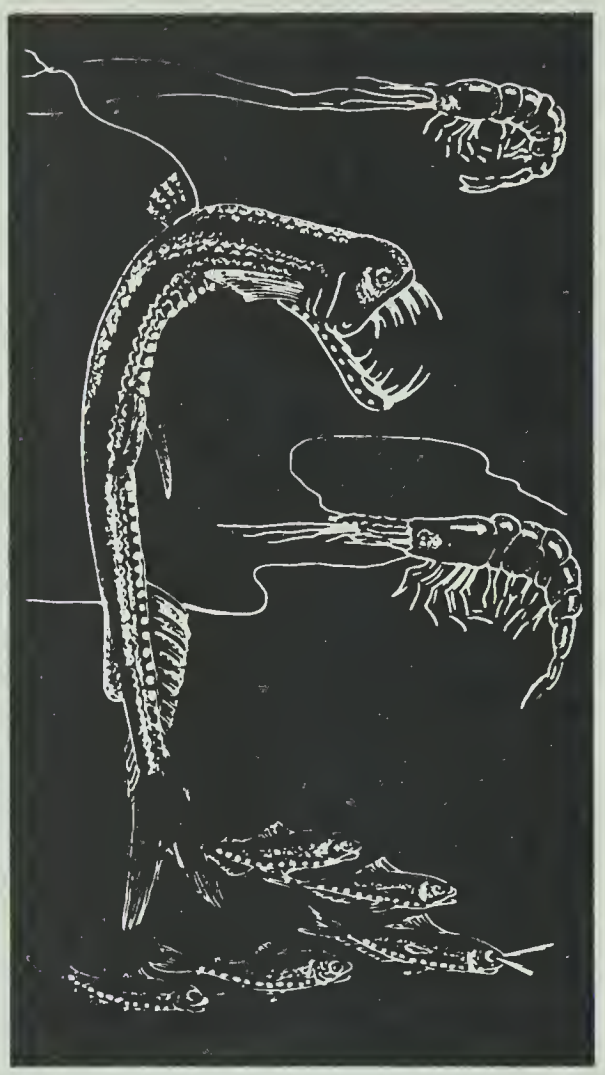
2-11. A2, B6, C5, D4, E1, F3

ACTIVITY EMPHASIS: Different animal and plant species are often specially adapted to the physical features of their environmental communities.

ACTIVITY 3: HOME, SWEET HOME

Lizards survive well in the desert. Penguins get along fine in antarctica. And some kinds of fish live only at the bottom of the oceans.





MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

If these animals were switched around and put in one another's environments, chances are they wouldn't live very long. Every type of plant and animal fits — is adapted to — certain features of its environment. It's adapted to the temperature range, the amounts of oxygen, the water, the sunlight, and the type of soil.

The adaptations of the fern plant are a good example. Open your *Community Atlas* to "Plate 2. Forest Community." Read the checked physical features under the "Special Features." Then answer the question below.

3-1. Tree tops receive direct sunlight; underneath, the light is indirect and dim.

- 3-1. What is special about the light in a forest?

Now read the facts about fern plants in the "Adaptation Example" on the same plate, and answer the following question.

3-2. Shade and indirect sunlight

- 3-2. What sort of light is best for a fern plant?

The ability of fern plants to grow well in dim light is an adaptation to the amount of light in a forest. The needs of the fern match the conditions of the forest. Now, look at the other checked physical features of a forest community. For each feature, try to find an appropriate adaptation of the fern plant.

☆ **3-3. What is special about the soil of a forest? How is the fern plant adapted to this type of soil?**

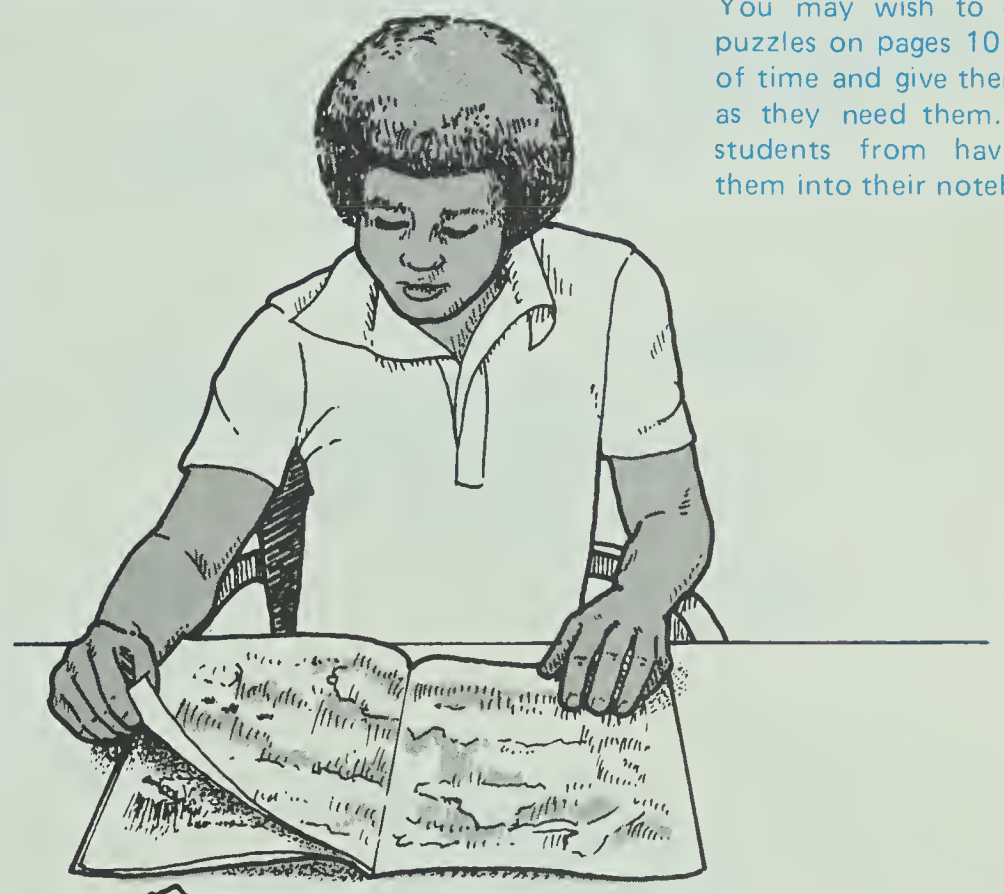
☆ **3-4. What is special about the amount of water in a forest? What are two ways that the fern plant is adapted to these water conditions?**

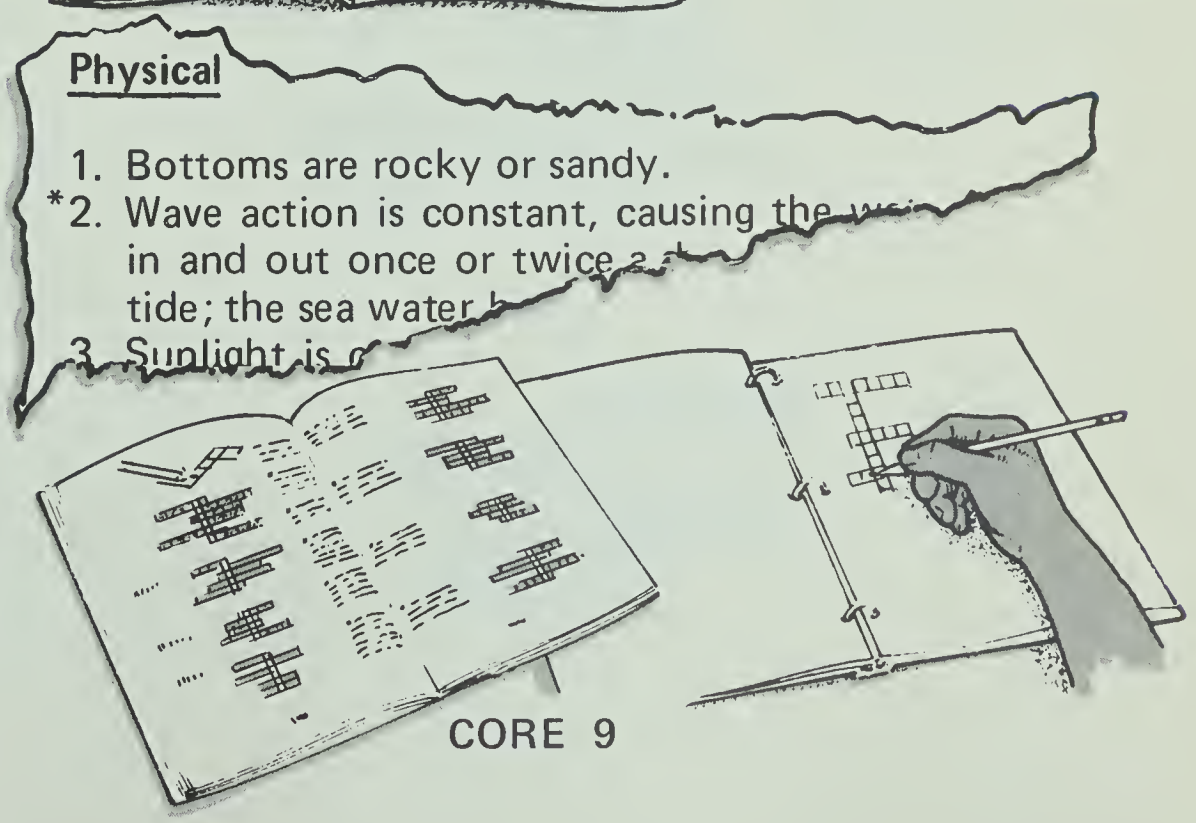
Now you're ready to do an investigation. You'll need your *Community Atlas*.

A. Look at the *Atlas* plate for each type of community in your local section. Read the checked physical features in the "Special Features." Also read the facts in the "Adaptation Example."

B. For each checked physical feature, try to find a matching fact about the plant or animal in the example. The fact should describe an adaptation to that physical feature. You may want to write these matches down. You'll need to remember them.

C. Now you're ready to do the puzzles on pages 10 and 11. Copy the puzzles, but not the clues, into your notebook. Copy only the puzzles for the communities in your local section.




Physical
1. Bottoms are rocky or sandy.
*2. Wave action is constant, causing the
in and out once or twice a
tide; the sea water
3. Sunlight is

3-3. It is rich in nutrients and is acidic. The fern plant needs acid soil.

3-4. There is much rainfall, the soil is moist, and the air is humid. The fern plant needs much moisture and has roots that get moisture from the air.

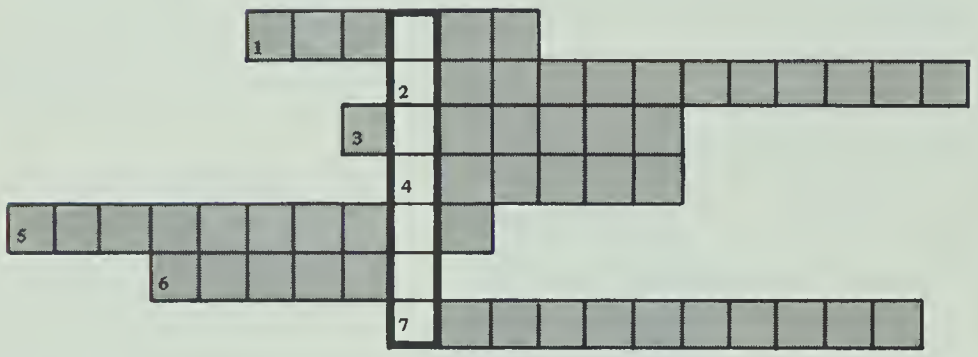
You may wish to duplicate the puzzles on pages 10 and 11 ahead of time and give them to students as they need them. It will save students from having to copy them into their notebooks.

Use the clues to figure out each word. Then, write the word in the proper numbered space. You should try to answer without any help. But if you can't remember some adaptations, look them up in your *Community Atlas*.

When you have filled in all the correct words for a puzzle, the letters in the white spaces will spell out a word. The word will describe an important feature of that community.

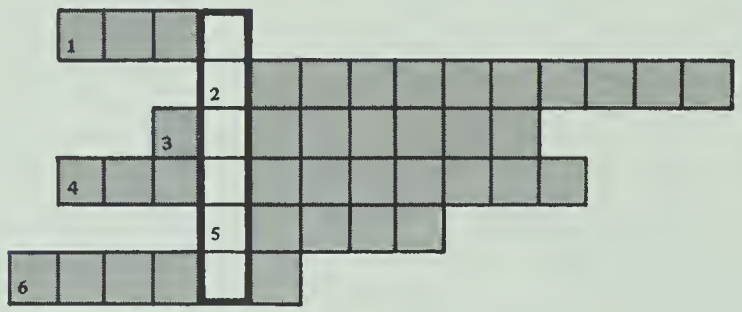
3-5. 1. stiCky
2. Undersurface
3. pRotect
4. Reduce
5. activitiEs
6. oxygeN
7. Temperature

Moving Fresh Water



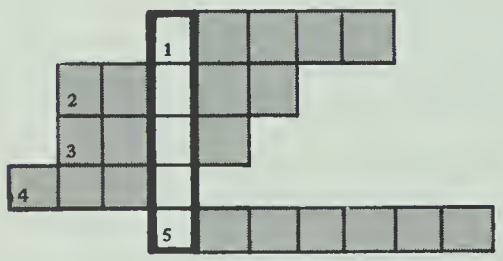
Urban

3-6. 1. damP
2. Environment
3. cOnstant
4. temPerature
5. Light
6. spacEs



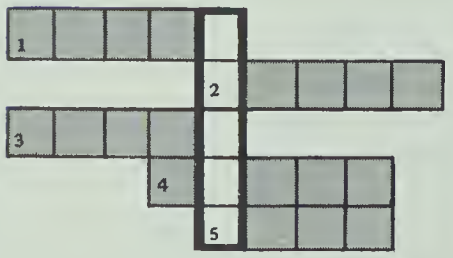
Seashore

3-7. 1. Wedge
2. smAll
3. moVe
4. tubE
5. Suction



Forest

3-8. 1. moisT
2. Roots
3. shadE
4. dEcay
5. Soil



● 3-5. In adapting to moving water, snails cling to underwater rocks or plants with their (1) (2). Their shells (3) them from rocks and pebbles in the current. Snails can also (4) their body (5). This is an adaptation to varying levels of (6) and to changing (7).

● 3-6. Cockroaches are adapted to urban humidity. They need an (2) that is (1). Since they live in buildings, the (4) must be warm and relatively (3). Being adapted to dimness, cockroaches avoid the (5) by squeezing into dark (6).

● 3-7. Sea urchins are adapted to wave motion in three ways. First, their spines allow them to (1) themselves firmly between rocks. Second, their (4) feet (3) along the bottom by means of (5). Third, sea urchins feed on (2) pieces of plants and animals broken up by wave action.

● 3-8. Ferns are well adapted to the dampness of the forest. They need a (1) environment, and their (2) can pick up water from the air. Leaves produce acid when they (4). Ferns are adapted to this. They need acid (5). Indirect light suits ferns. They do best in the (3).

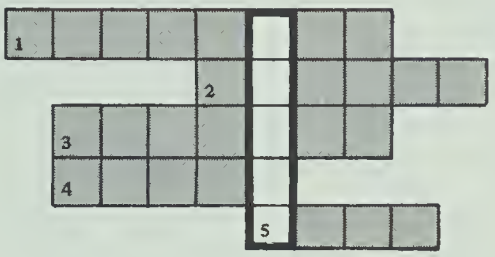
● 3-9. Sunfish are __(2)__ to the amount of light penetrating the water. From below they look __(1)__, blending with the color of the surface. Their gills __(3)__ the available oxygen from the water. Being cold-blooded, sunfish have a __(4)__ that tends to match that of the __(5)__.

Standing Fresh Water

3-9. 1. White
2. adApted
3. Take
4. tEmperature
5. wateR

● 3-10. Living in the open, grasses require lots of direct __(1)__ for best __(2)__. They survive cold or drought by becoming __(3)__. They are adapted to evaporation and limited rainfall by having __(4)__ that penetrate the __(5)__ deeply.

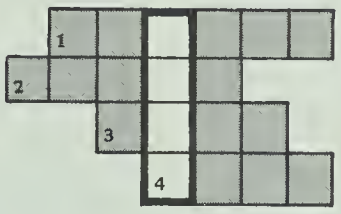
Grassland



3-10. 1. sunliGht
2. gRowth
3. dormAnt
4. rootS
5. Soil

● 3-11. Cacti are adapted to the extreme dryness of the desert. Their __(1)__ are hard spines, and their roots are either very __(4)__ or spread __(3)__ to pick up rainwater. Cactus stems often __(2)__ water.

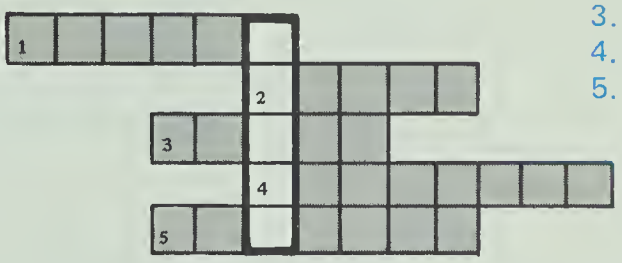
Desert



3-11. 1. leAves
2. stoRe
3. wIde
4. Deep

● 3-12. Oysters' adaptation to the flow of coastal tides and currents is to attach themselves to solid objects by their __(1)__. When __(5)__ at low tide, oysters are out of the __(2)__, so they close their shells to prevent loss of __(4)__. Thus oysters __(3)__ to the same conditions of temperature, saltiness, and sunlight as the algae they feed on.

Coastal Wetlands



3-12. 1. shellS
2. Water
3. adApt
4. Moisture
5. exPosed

You've looked at just a few examples for each community. All living things are adapted in many ways to both the physical features and the other living things in their particular community. If they weren't, you probably wouldn't find them there.

ACTIVITY EMPHASIS: Adaptation is thought to occur through the process of natural selection. The coloration of the peppered moth provides an example.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

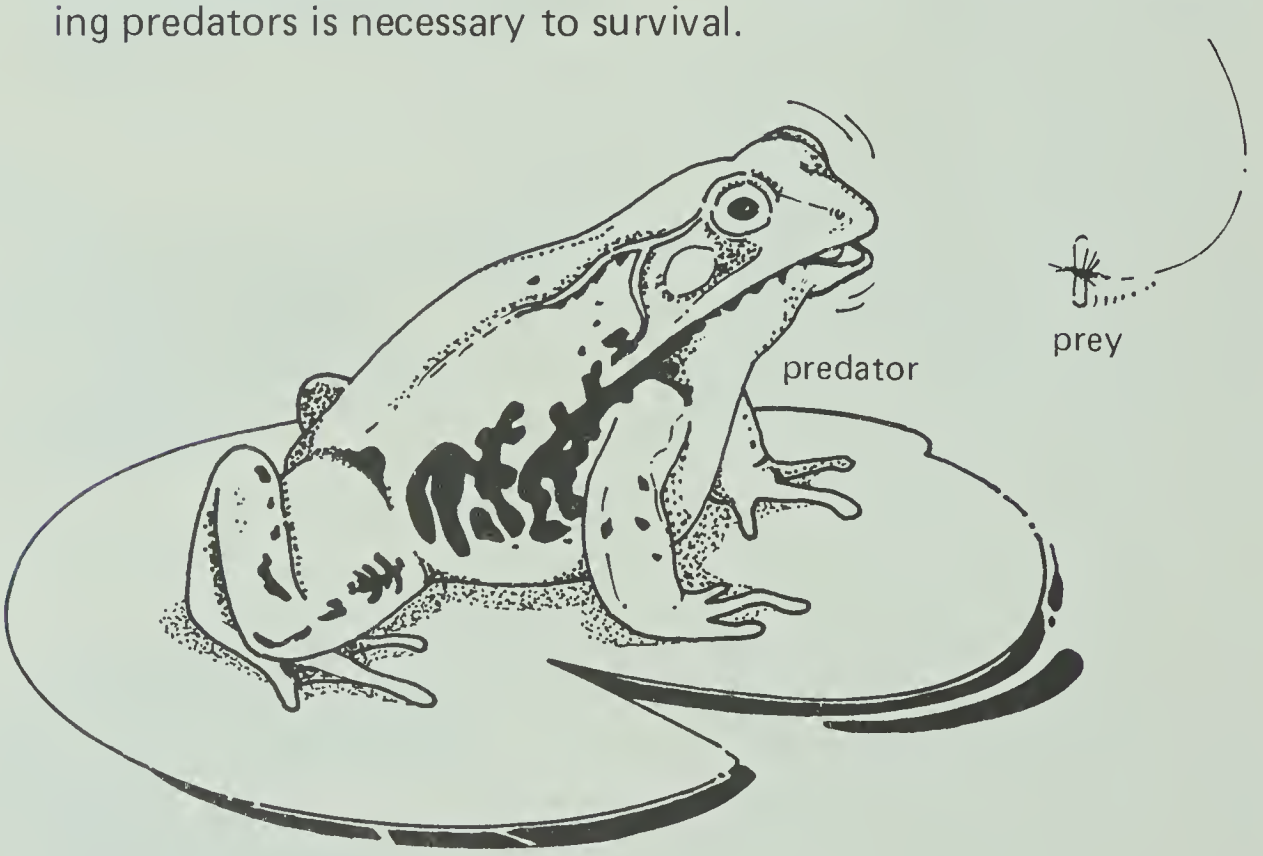
ACTIVITY 4: PROTECTIVE COLORATION

The members of a species (kind) of organisms that live in a local community are called a *natural population*. To survive, all the members of a population need certain resources such as food, water, shelter, and oxygen. But often the environment does not have enough of these resources. The population may — and often does — produce more offspring than the resources can support. This causes competition for the resources. The offspring that can get the resources will survive. The others will die.

4-1. The survivors compete better than the nonsurvivors for the limited resources (food, water, shelter, and oxygen).

● 4-1. Why will some members of a natural population, but not others, survive to adulthood?

There's another sense in which members of a population are in competition. They're all trying to stay safe. Predators feed upon the unsuccessful members of the population — the prey. Avoiding predators is necessary to survival.



4-2. A predator; the prey

● 4-2. What do you call the kind of animal that kills other animals and eats them? What do you call the animals that are eaten?

Many scientists believe that the characteristics of a population can change. These changes occur gradually over many generations. They occur because some individuals are better able than others to get food, water, oxygen, and suitable shelter. This process of change is referred to as the *theory of natural selection*. It's summarized briefly in Figure 4-1 (page 13).

THE THEORY OF NATURAL SELECTION

1. Each member of every species of living thing is different from every other member of that species. Each has some slightly different traits (characteristics). The traits are determined by inherited genes (tiny information units in the cells).

2. In each generation, every species tends to produce more offspring than the environment can support. Thus, there is usually a life-and-death competition for food, space, and mates.

3. Because of differences in traits, some members of a species are better able than others to survive and reproduce. These survivors tend to pass their "survival-plus" traits on to their offspring through their genes.

4. The living conditions in the environment help determine ("select") the survivors. As conditions change, new survival traits may be needed and old ones may become useless or even dangerous. Over generations, the traits passed on by survivors may come to reflect the changed environment.

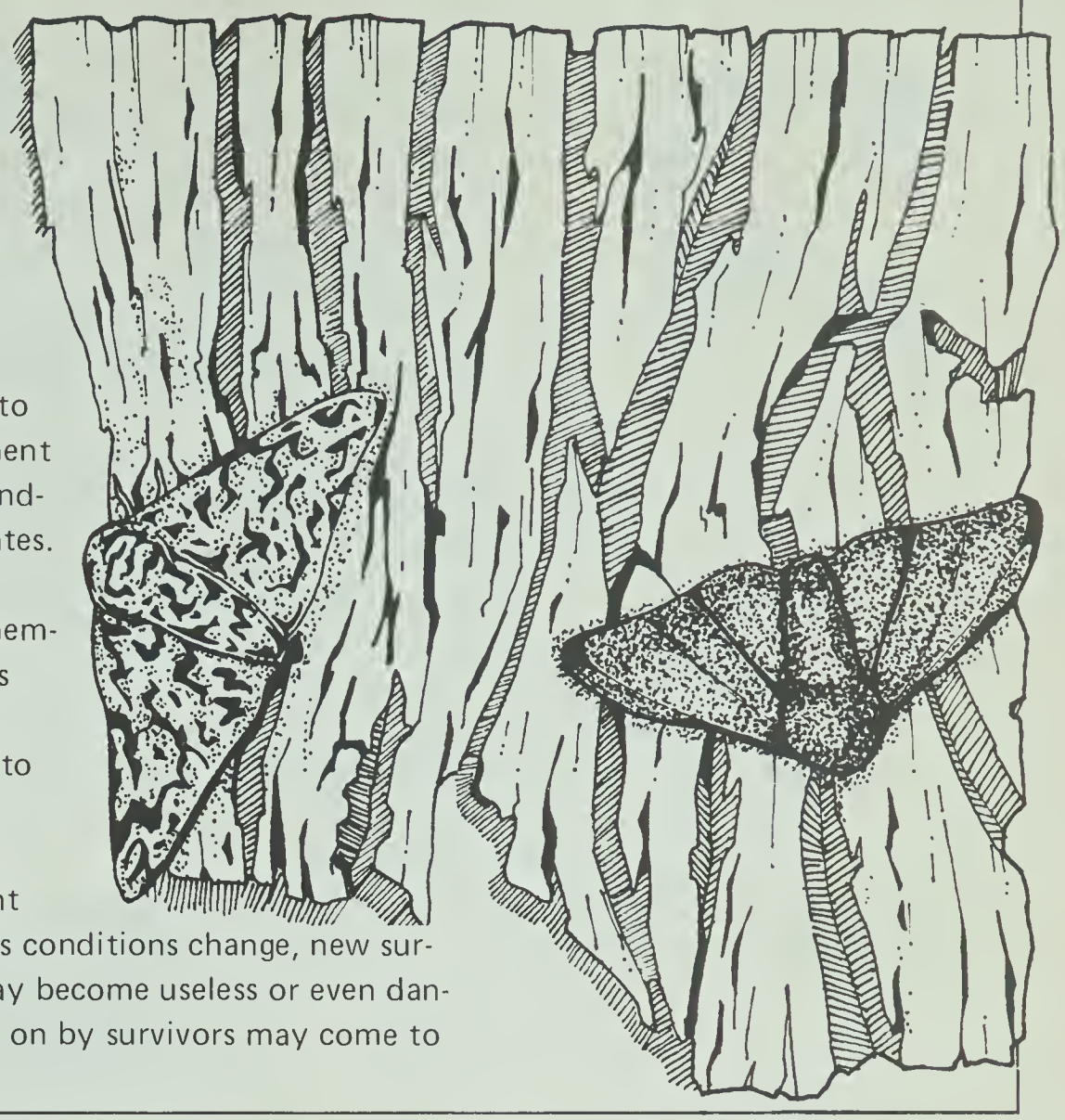


Figure 4-1

● 4-3. How are the two peppered moths in Figure 4-1 above different? Which one — left or right — is easier to pick out on its bark background?

Peppered moths spend a lot of their time clinging to the bark of trees. The moth shown on the left in Figure 4-1 above tends to blend in well with the color of the bark. The moth on the right blends in less well. Some organisms tend to get visually "lost" in their surroundings. This tendency, called *protective coloration*, helps the organisms to avoid predators.

● 4-4. Which peppered moth in Figure 4-1 above seems to have better protective coloration — the light moth or the dark moth?

● 4-5. What survival value do you think protective coloration has?

Now, here's the story of the peppered moths. They live in England. As you have seen, there are two varieties — light and dark. They are members of the same species, however, and can mate with each other.

4-3. The one on the right is mostly black, and the one on the left is white with black spots. The right (dark) moth is easier to pick out.

4-4. The light moth

4-5. The ability to blend into its normal surroundings helps protect an organism from its enemies (predators); thus, it helps the organism to survive.

4-6. The dark; the light

Many years ago, the trunks of large shade trees got covered with growths of pale lichens [LY-kinz], which are mosslike plants. When dark peppered moths clung to these tree trunks, they could be easily seen by insect-eating birds. Light peppered moths blended in much better. So more dark moths were eaten by the birds.

As a result, the peppered-moth population came to consist mainly of light moths. The dark variety became quite rare.

● 4-6. Which type of peppered moth was more visible to passing birds — the light or the dark? Which was more likely to survive?

In a time when lichen-covered trees had light-colored trunks and branches, the light moths had the better chance to survive. They were better adapted to the living conditions.

But when factories were built in England, conditions in the cities began to change. Factory smoke and soot coated the trees and grass. The lichens died, and the bark of tree trunks was stained dark.

4-7. The dark ones could survive better because they would blend into the background (tree bark) better than the light ones. They wouldn't be eaten by the birds in such great numbers.

4-8. The light ones would better survive attacks by their predators because of their coloration.

● 4-7. Factories and their smoke produced new environmental conditions in the cities of England. Under these new conditions, which type of peppered moth could be expected to survive in greater numbers? Why?

● 4-8. The English countryside remained mostly unaffected by factory smoke and soot. Which type of moth could be expected to survive there in greater numbers? Why?

☆ 4-9. After the factories were built in England, changes occurred in the peppered-moth population. Which of the following statements help to explain those changes in terms of natural selection?

A. Moth coloration — light or dark — is an inherited trait.
B. For peppered moths, light coloring is a survival advantage in clean environments but a disadvantage in smoky cities.
C. Moths get darkened by smoke and can better hide from predators (birds) in the cities.
D. Moths that survive tend to pass their color trait on to their offspring, increasing that trait's occurrence in the population.
E. Changes in the city environment gradually "selected" the dark color trait because the dark moths were better adapted to the new environmental conditions.

4-9. A, B, D, and E

● 4-10. Better pollution control is helping clean up English cities. How might this affect the color traits of future peppered-moth populations?

4-10. The environmental conditions might return to their pre-factory state. This would result in lighter tree trunks and a survival advantage of light-colored peppered moths. The population might become mainly light again.

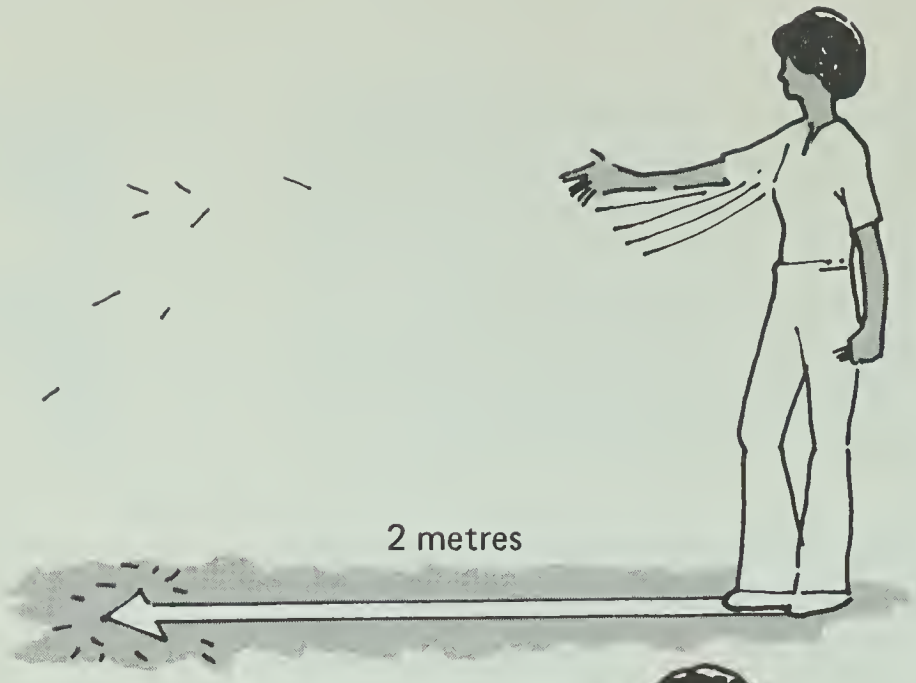
You can do an interesting investigation. You'll observe a predator (a classmate) capture prey (colored toothpicks) under certain environmental conditions (on a green surface). You'll see what helps toothpicks in their "struggle for survival." You'll need a partner and the following materials.

A square of green carpet, with a deep pile works fine for this activity. It is easier to control than having the students go outside, and it will work in all weather.

watch or clock with second hand
100 green toothpicks in box
100 red toothpicks in box
metre stick
green surface

A. In your notebook, make a table similar to this one. Make your table for five generations. (Note: The "No." in the table will be the number of *surviving* toothpicks.)

GENERATION	TOTAL POPULATION	GREEN		RED	
		No.	% of Total Population	No.	% of Total Population
Start	30	15	50%	15	50%
1					
2					
3					
4					
5					



B. Go to the special area that your teacher has set aside for this investigation. Mix together 15 red and 15 green toothpicks. Toss them, a few at a time, so that they land spread out about two metres away on the special green surface.

C. Have your partner act as the predator. Time your partner as he or she picks up as many toothpicks as possible in 10 seconds. Stop your partner when 10 seconds are up.

D. The predator probably didn't capture all the toothpicks of either color. Thus, part of each population survived. Put those toothpicks that were captured back in their boxes. Pick up those toothpicks that survived and count them.

● 4-11. What is the number of surviving green toothpicks? Surviving red toothpicks?

E. The surviving toothpicks will now produce offspring. Match each surviving toothpick with another toothpick of the same color.

The surviving and the matched toothpicks make up the first generation. For example, suppose seven green toothpicks had survived. You would match seven new green toothpicks to those first seven. Then you would have fourteen green toothpicks in the first generation. If three red toothpicks survived, you'd have six reds in the first generation.

F. On the table in your notebook, record the number of toothpicks of each color that you have in Generation 1.

● 4-12. What was the number of green toothpicks in Generation 1? Of red toothpicks in Generation 1?

4-12. [Answers will vary.]

G. You'll work with a total of five generations, so do four more trials. Start by tossing all the toothpicks for Generation 1. Then repeat Steps C through E for each new trial.

H. For the population of each generation, calculate the percentages of green and of red. Do this by dividing each color's total by the population total and multiplying by 100. (For example, if Generation 1 had fourteen greens and six reds, that's a population of 20, a green percentage of 70, and a red percentage of 30.) Enter your percentages in the table.

● 4-13. Did the percentages of green and red toothpicks remain the same through all five trials? If not, why did they change?

4-13. No, the percentage of greens increased. The greens blended into the surface and were harder for the predator (partner) to find.

● 4-14. Which toothpicks seemed better equipped to survive an attack by the predator?

4-14. The green ones

● 4-15. Suppose you tossed the toothpicks onto a sidewalk instead of onto the green surface. How might that affect the results of your investigation? (Try it and see.)

4-15. Neither color toothpick would have an advantage.

● 4-16. There's a theory that explains gradual changes in a natural population as resulting from the "elimination of less-well-adapted individuals in the struggle for survival." What is this theory called?

4-16. The theory of natural selection

● 4-17. Which toothpicks — green or red — showed good protective coloration on the green surface? What color would a toothpick population mainly be after ten generations of "living" there?

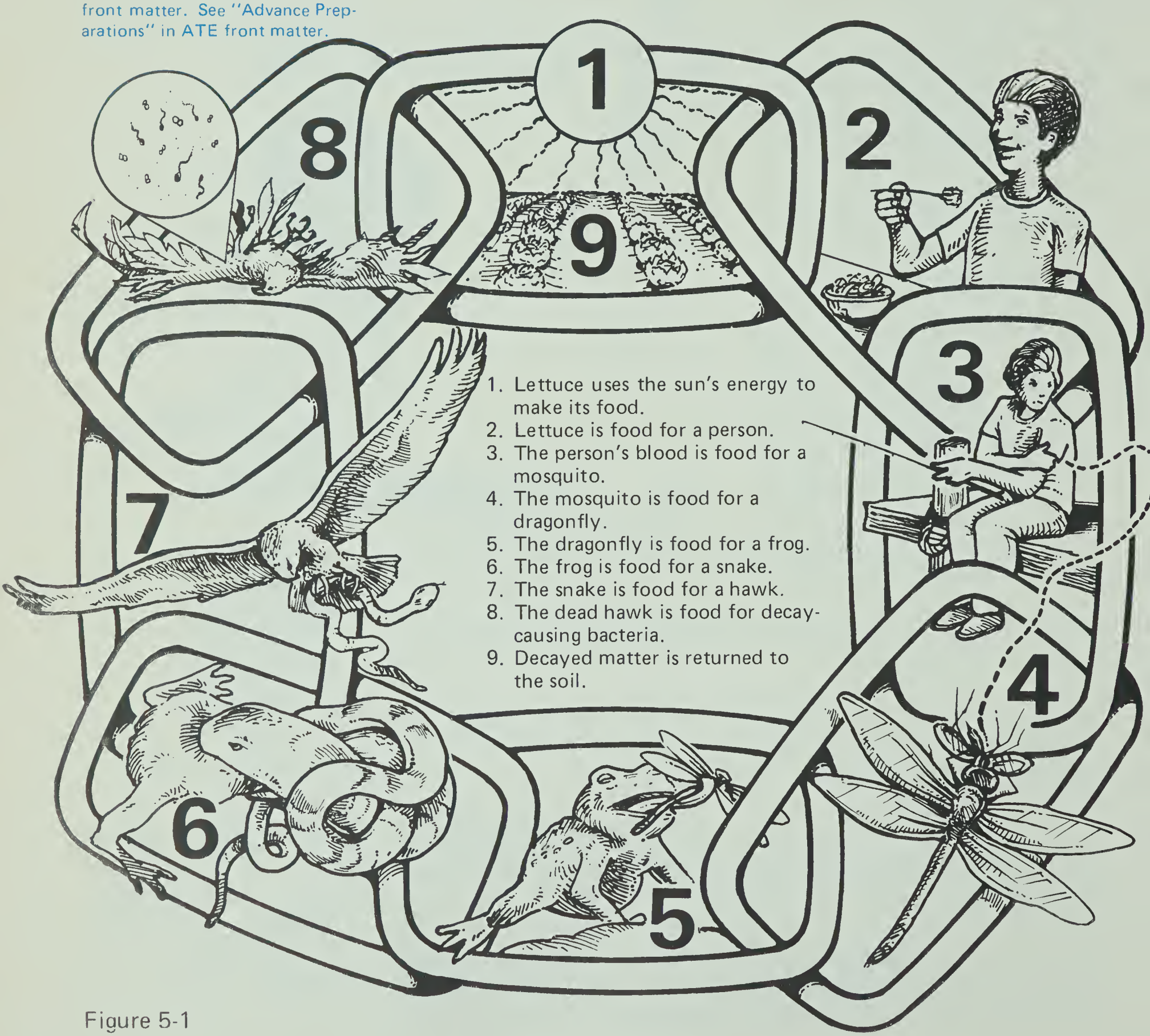
4-17. Green; green (with perhaps a few reds)

ACTIVITY EMPHASIS: Part of the interdependence of organisms in an ecological community can be schematized in food chains and food webs. These can be simulated in the classroom, using the *Community Atlas*.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

ACTIVITY 5: CHAINS AND WEBS

At one time or another you've probably been a source of food for many organisms. Does that sound impossible? Consider the chain of events shown in Figure 5-1 below.



1. Lettuce uses the sun's energy to make its food.
2. Lettuce is food for a person.
3. The person's blood is food for a mosquito.
4. The mosquito is food for a dragonfly.
5. The dragonfly is food for a frog.
6. The frog is food for a snake.
7. The snake is food for a hawk.
8. The dead hawk is food for decay-causing bacteria.
9. Decayed matter is returned to the soil.

Figure 5-1

● 5-1. There's one original source for all the energy in the food chain shown in Figure 5-1 (page 18). What is this original source of energy?

5-1. The sun is the original source. Its energy is captured by plants such as the lettuce.

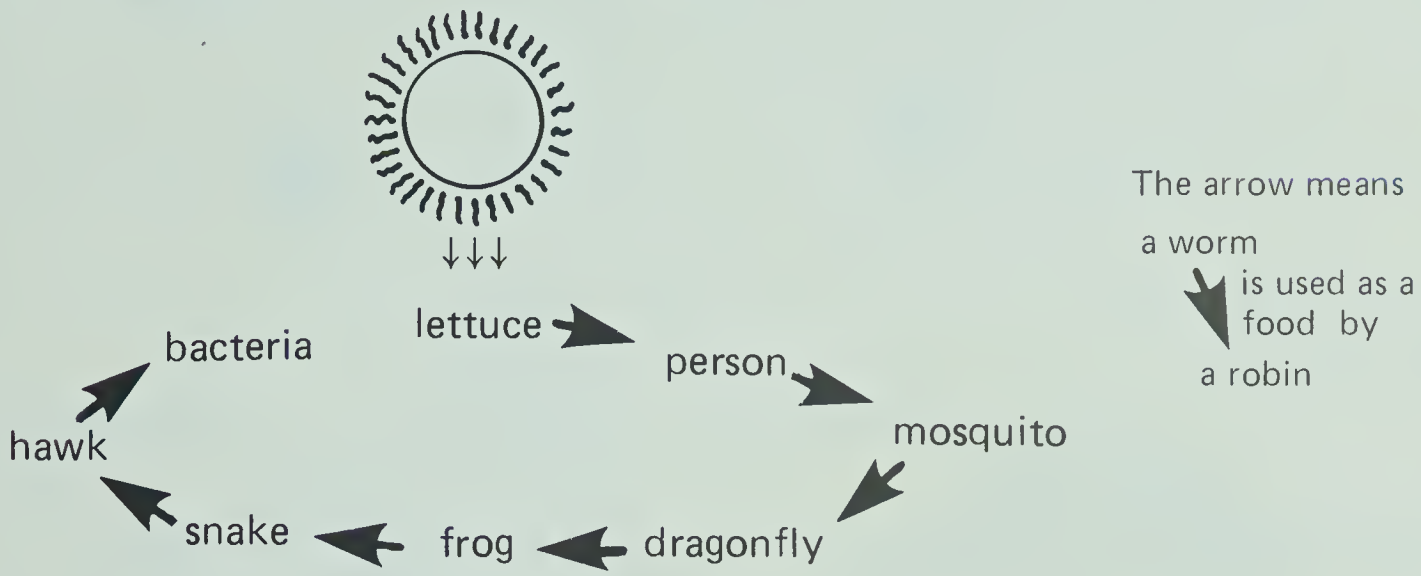
● 5-2. The person shown in Figure 5-1 (page 18) was part of the hawk's food chain. Describe the chain of events that connected the person and the hawk.

5-2. The mosquito took some of the person's blood. The dragonfly ate the mosquito, and the frog ate the dragonfly. The snake ate the frog, and the hawk ate the snake. The hawk thus got a small part of the person's blood.

● 5-3. What organisms in Figure 5-1 (page 18) help to return decayed matter to the soil?

5-3. Decay-causing bacteria

All organisms participate in series of events like those shown in Figure 5-1. These series are called *food chains*. Each link in a chain can be shown by drawing an arrow from the food source to the food consumer. For example, the food chain in Figure 5-1 looks like this.



The sun is the original energy source in any food chain. The single arrows are read as "is used as a food by."

● 5-4. Explain the food chain shown above.

5-4. The sun's energy is used by lettuce to make its food. Lettuce is used as a food by a person. The person is used as a food by a mosquito. The mosquito is used as a food by a dragonfly. The dragonfly is used as a food by a frog. The frog is used as a food by a snake. The snake is used as a food by a hawk. The hawk is used as a food by bacteria.

● 5-5. Draw a food chain involving the following:
A. Fungus plants (decay organisms)
B. Corn-plant seeds (eaten by mice)
C. Owl (when dead, eaten by decay organisms)
D. Mice (eaten by owls)

5-5. Sun ⇉ B → D → C → A

☆ **5-6. Draw a food chain involving the following:**
A. Caterpillar (eaten by robin)
B. Bush leaves (eaten by caterpillar)
C. Robin (eaten by owl)
D. Owl (when dead, eaten by decay organisms)
E. Bacteria and fungus plants (decay organism)

5-6. Sun ⇉ B → A → C → D → E

Food chains consist of three types of organisms. They are called *producers, consumers,* and *decomposers*. These are described in Figure 5-2 below.

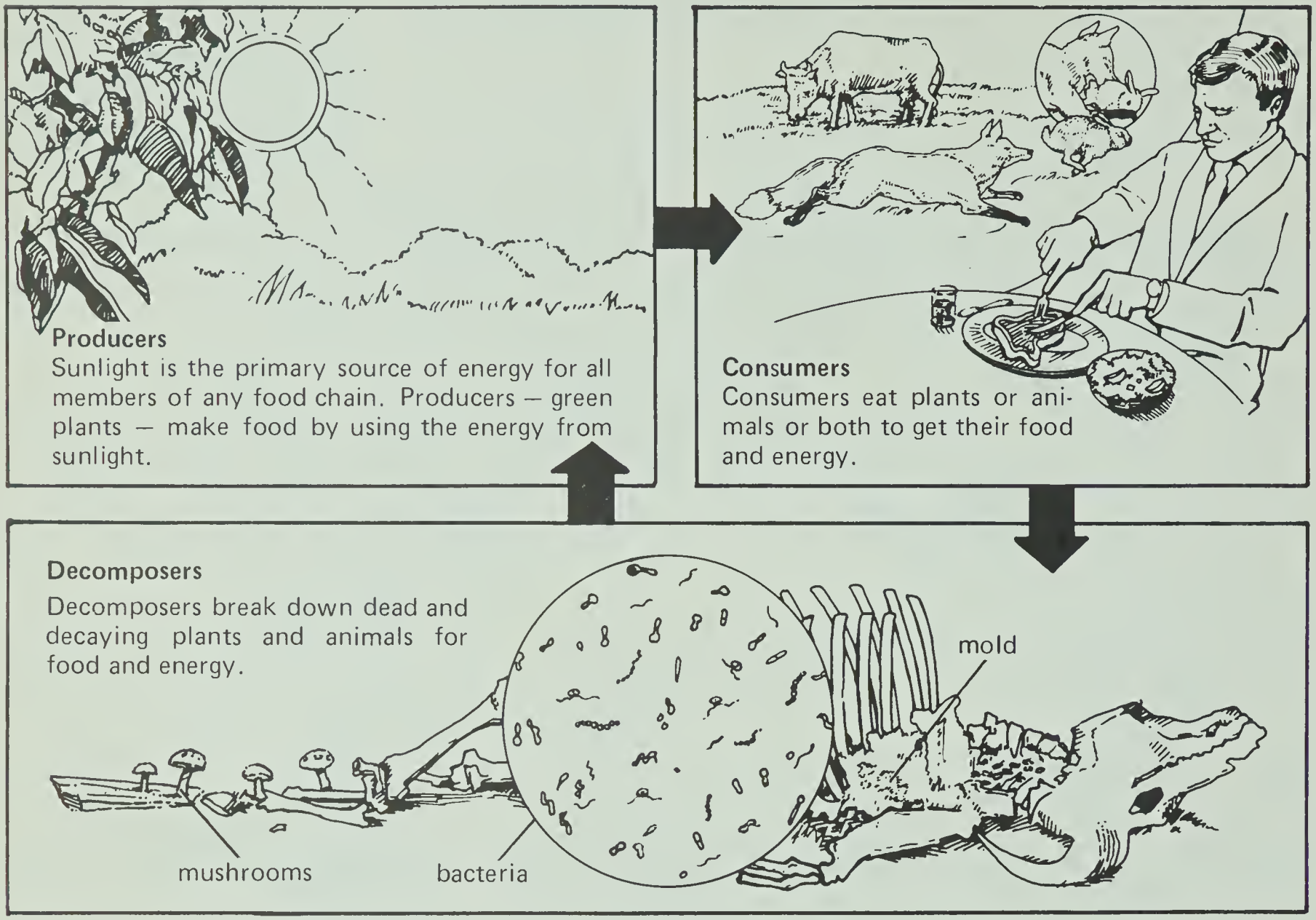

Producers
Sunlight is the primary source of energy for all members of any food chain. Producers – green plants – make food by using the energy from sunlight.
Consumers
Consumers eat plants or animals or both to get their food and energy.
Decomposers
Decomposers break down dead and decaying plants and animals for food and energy.
mold
mushrooms
bacteria

Figure 5-2

5-7. Producers use light from the sun to produce food. Consumers get food and energy from producers and other consumers. The decomposers get food and energy from dead or decaying plants and animals.

5-8. The person, mosquito, dragonfly, frog, snake, and hawk are consumers. The lettuce is the producer. The bacteria are the decomposers.

5-9. The sun

5-10. Producers

- 5-7. What is the direct source of food and energy for the producers in a food chain? For the consumers? For the decomposers?

- 5-8. Name the consumers shown in Figure 5-1 (page 18). Name the producer. Name the decomposers.

- 5-9. What is the original source of energy for all plants and animals in a food chain?

- 5-10. Are a pine tree, grass, and a cactus producers, consumers, or decomposers?

● 5-11. Clams feed on tiny organisms in the water. Are clams producers, consumers, or decomposers?

5-11. Consumers

● 5-12. Do bacteria and fungi act within a community as producers, consumers, or decomposers?

5-12. As decomposers

Get the *Community Atlas.* Turn to "Plate 5. Urban Community." Look at the "Food Relationships" section.

● 5-13. Name the three producers in the Urban Community shown in Plate 5 of the *Community Atlas*. Name the five consumers. Name the two decomposers. What is the original source of energy for the food web?

5-13. Crop plants, grasses, and plants that grew seeds; house mouse, cockroach, house rat, dog and cat; bacteria and fungi; the sun

In examining food relationships in the urban community, you should have noticed something. The network of food relationships consists of several interconnected food chains. Some consumers have more than one food source. And some food sources supply more than one consumer.

That's what a real community food system is like. A number of food chains are interwoven. Together they form a *food web*.

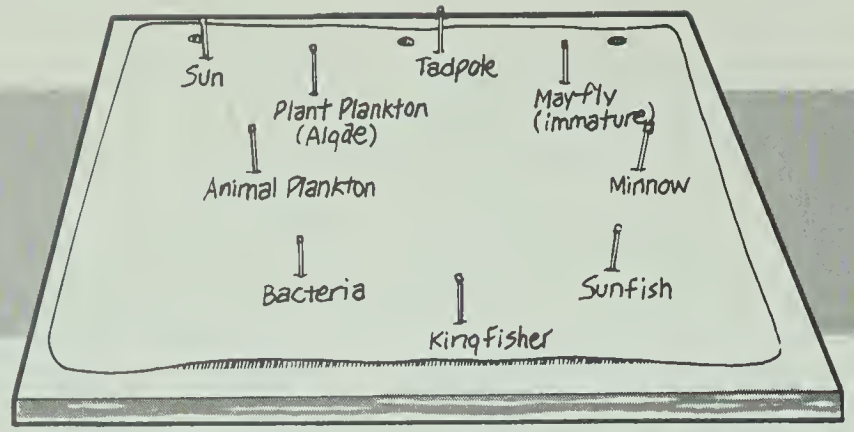
☆ **5-14. What makes up a food web?**

5-14. A number of interconnected food chains

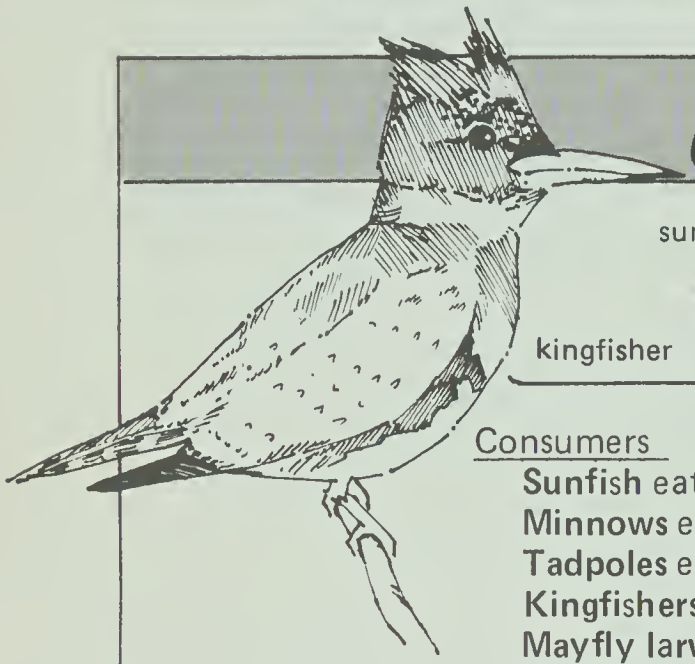
Now examine another food web. You'll need the following materials.

sheet of notebook paper
food-web board
spool of string
scissors

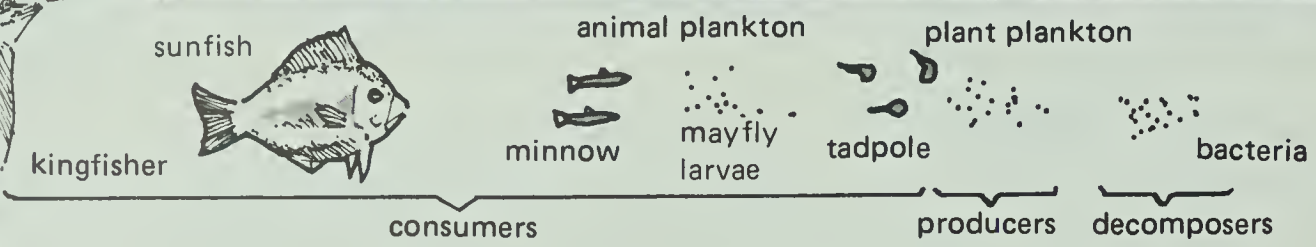
A. Place the sheet of notebook paper over the nails on the food-web board. Press the paper down so it is flat on the board and the nails are sticking through.



B. On the paper, label each of the nails as shown. Be sure the *sun* label is next to the nail in the corner. Then look at Figure 5-3 below to see what eats what in this food web.



Strands in the Web



Consumers

Sunfish eat animal plankton, plant plankton, tadpoles, minnows, and mayfly larvae.
Minnows eat animal plankton, plant plankton, and mayfly larvae.
Tadpoles eat plant plankton.
Kingfishers (birds) eat sunfish and minnows.
Mayfly larvae (immature insects) eat animal plankton and plant plankton.
Animal plankton (microscopic water animals) eat plant plankton and bacteria.

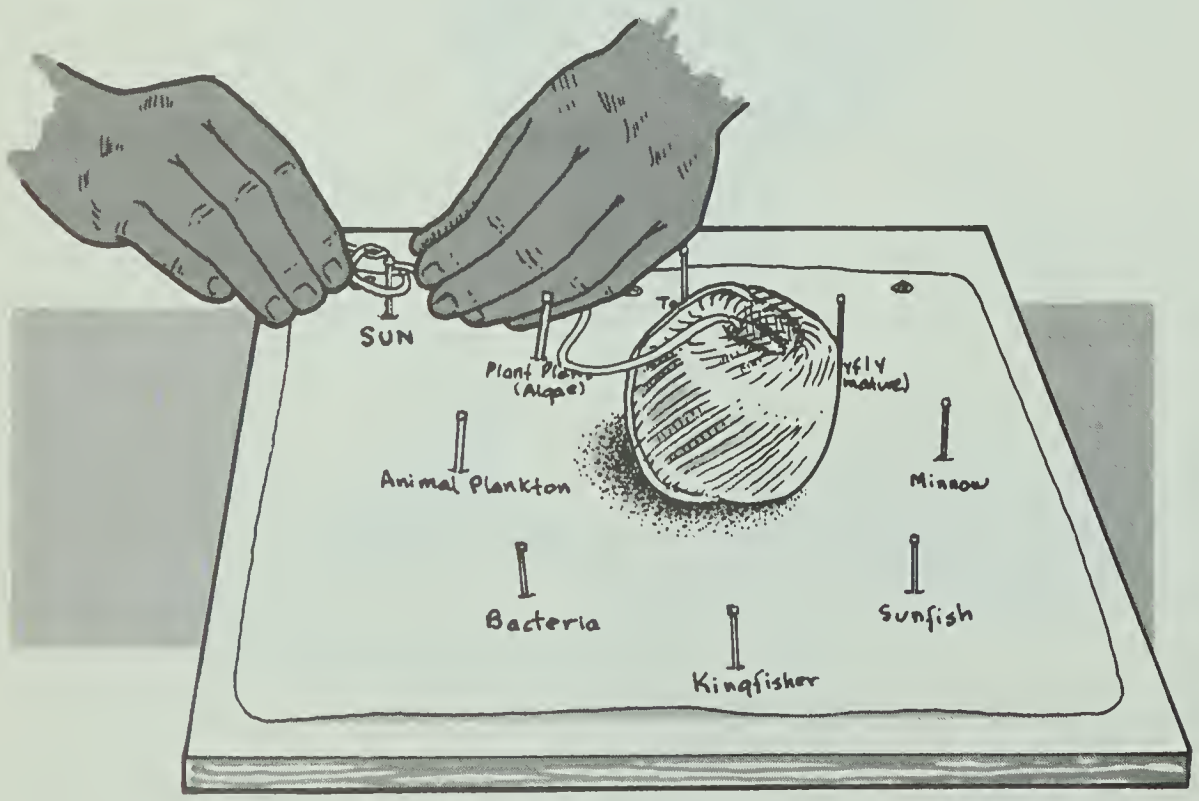
Producers

Plant plankton (microscopic plants in the water) make their own food.

Decomposers

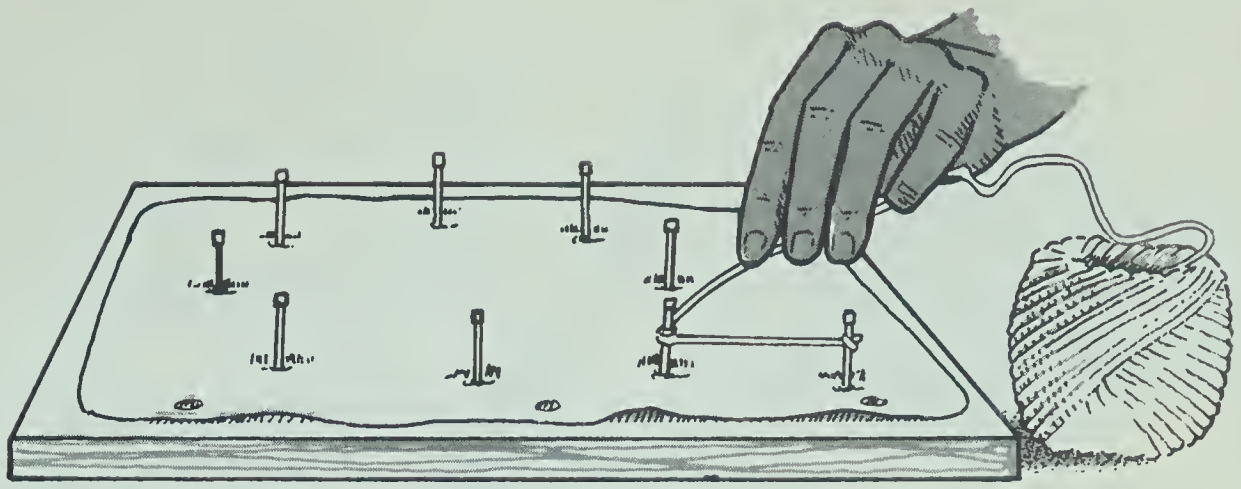
Bacteria (microscopic one-celled organisms) eat any dead or decaying matter of all the other organisms.

Figure 5-3



C. Put the spool of string in the middle of the board. Tie the end of the string to the nail labeled *sun*.

D. Decide which organism on the board uses the sun's energy to make food. Extend the string from the *sun* nail to this organism's nail. Wrap the string around this nail. You now have your first link in the food web.

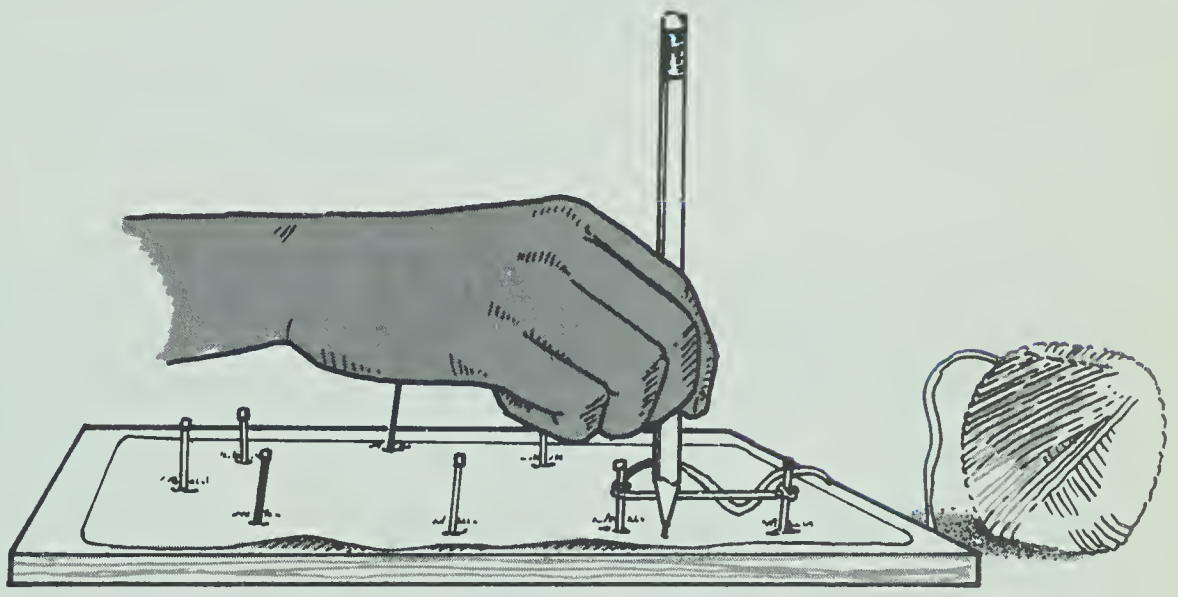


- 5-15. Which organism uses the sun's energy to make food?

5-15. Plant plankton

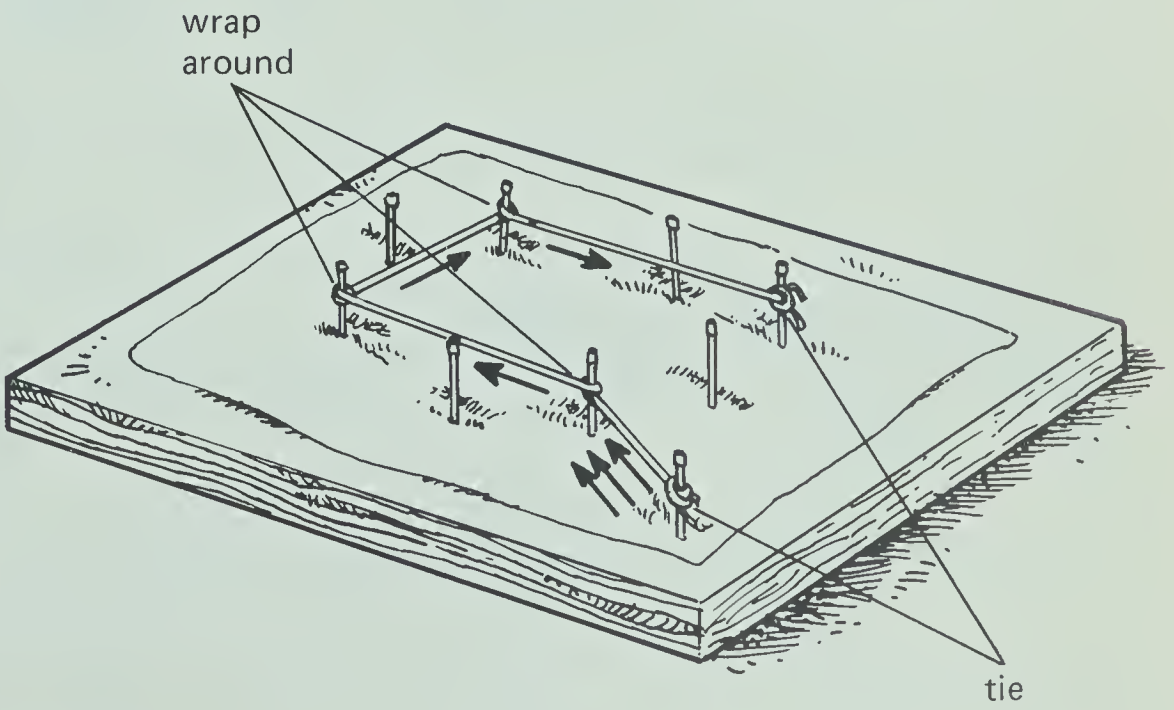
E. Along the string, draw three arrows pointing from the sun's nail to the first organism's nail. These arrows show that the organism uses the sun's energy to make food.

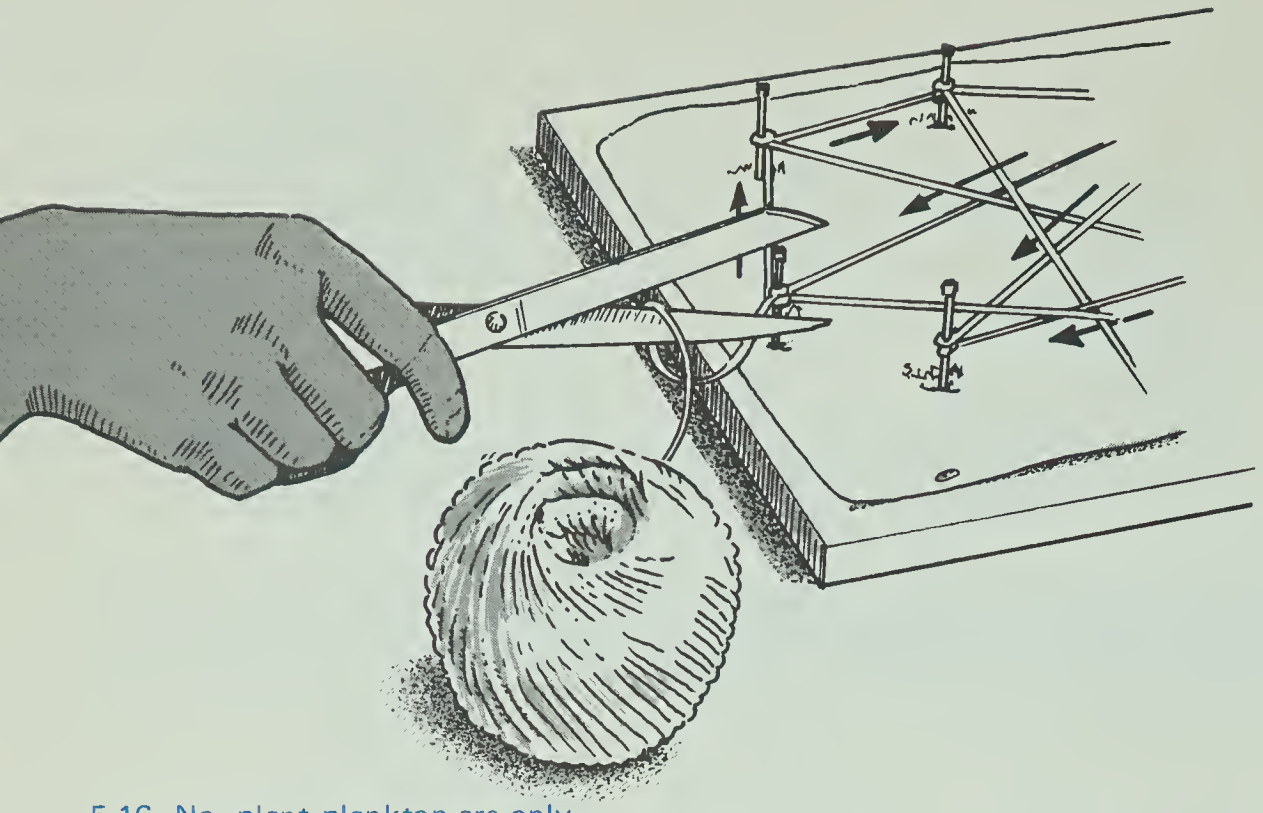
F. Now decide which organism on the board uses that food maker as its food. Extend the string to this consumer organism. Wrap the string around its nail. Draw one arrow to it from the food maker.



G. Continue the string on from the organism in Step F to the organism that uses it for food. Wrap the string around its nail. Draw one arrow along the string.

H. Continue the string to the nail for the next consumer and from that nail to the next consumer, until the string reaches the end of the food chain. For instance, your string may go from the nail for the sun to plant plankton to mayfly to sunfish to bacteria. Cut the string, and draw the arrows.





I. Go back to the food maker (Step E) and start again. Continue the process until every nail except the sun's is connected to at least two other nails. And be sure to draw an arrow from food source to consumer each time. When you're sure you are finished, cut the string. Tie the loose end to the last nail.

5-16. No, plant plankton are only producers.

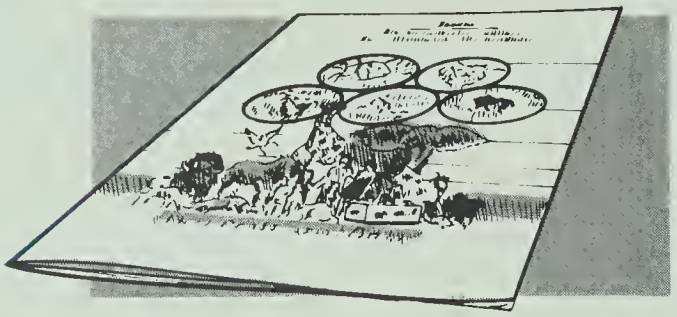
- 5-16. Does every organism on the board have at least one source of food?

5-17. Yes

- 5-17. Is every organism a food source for at least one other organism?

5-18. The bacteria's nail has the most. All organisms die and are subject to decay.

- 5-18. Which organism's nail has the most string connections and arrows? Tell why this is so.



J. Look through the *Community Atlas*. Find the community whose food web is closest to the one you've just constructed.

5-19. The Standing Freshwater Community has the same organisms and their food relationships are the same.

- 5-19. Which community in the *Atlas* has a food web like the one you've just constructed? How could you tell?

K. Turn in the *Atlas* to the plates for the communities in your local section. Look at the "Food Relationships" section in each. Then answer the following questions about your local food webs.

5-20. None; all organisms are a part of the local web — as consumers, producers, or decomposers.

- 5-20. In the communities in your local section, what organisms are not part of the food web? Explain your answer.

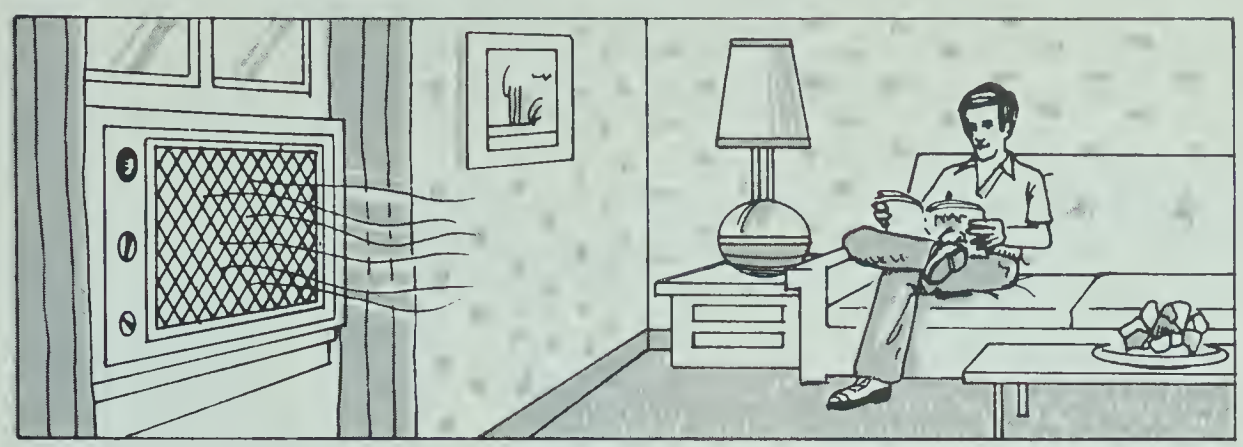
5-21. The sun

- 5-21. What is the energy source for each of the producers in the food webs in the communities in your local section?

ACTIVITY 6: NATURAL CYCLES

ACTIVITY EMPHASIS: Water, carbon, oxygen, and nitrogen, which are being continuously recycled, are important to all forms of life.

MATERIALS PER STUDENT LAB GROUP: None



Your environment is probably very different from that of the penguins shown in Figure 6-1 below. Even so, you and a penguin need some of the same things in an environment in order to survive. You both need enough air to breathe and enough food to eat. You both need enough water to drink and enough space for growth and reproduction.

Figure 6-1

Both of you also need the right temperatures, light, and humidity. If all of these factors are not favorable, the penguins can't survive for long. And neither can you. All plants and animals, including people, need their own special environmental "recipe." But all the different "recipes" have a lot in common. In particular, they all call for water, carbon, oxygen, and nitrogen. These four substances, in varying amounts, are necessary to all life forms.

But the total amounts of these substances on Earth are more or less fixed. Organisms continue to use them because they are recycled in the environment.

First, take a look at the water cycle shown in Figure 6-2 below.

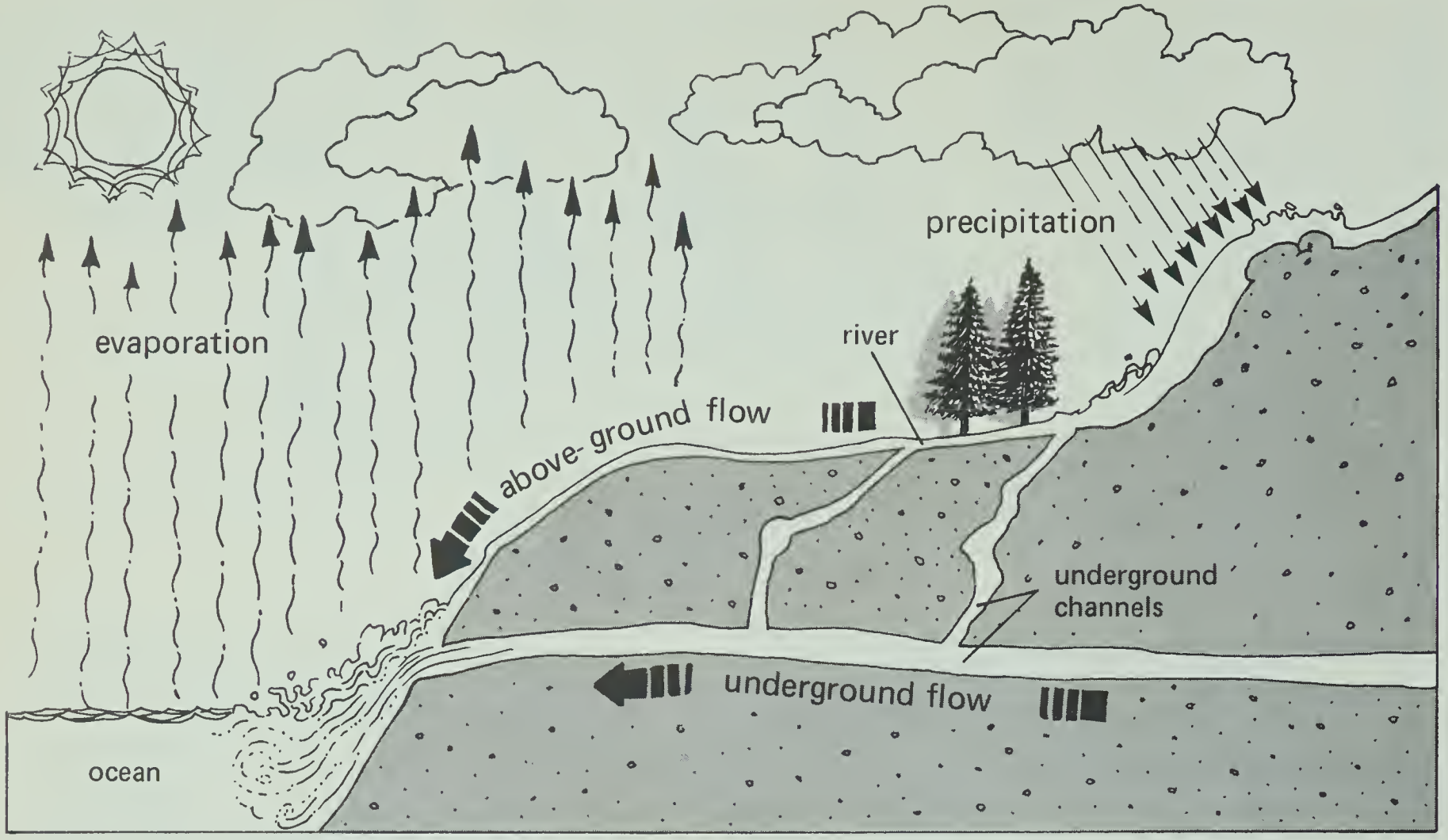


Figure 6-2

The sun heats water from lakes, streams, and oceans. The water forms into clouds by evaporation.

Water falls to Earth from the clouds as precipitation (rain or snow). Above ground, it flows into lakes, rivers, and streams, and finally into the oceans. It can also flow to the oceans underground, in cracks and channels between the rocks.

All water that falls on land and sea comes from the oceans and eventually returns to them. The oceans cover three-fourths of Earth's surface. Their water supports all life.

6-1. Evaporation

- 6-1. Look again at Figure 6-2 above. What process takes water from the land surface, lakes, streams, and oceans and forms it into clouds?

6-2. Precipitation

- 6-2. What process transfers water from the clouds to land and water surfaces?

6-3. Underground flow and above-ground flow

- 6-3. In what two ways is water moved from one place on Earth to another?

6-4. Evaporation, precipitation, underground flow, and above-ground flow

☆ **6-4. List the four main parts of the water cycle.**

Another great natural cycle involves oxygen and carbon dioxide. Carbon dioxide, CO_2, is a compound of oxygen, O_2, and carbon, C. Animals breathe in oxygen to get energy from food — by respiration. In the process, they produce carbon dioxide and breathe it out.

Plants use carbon dioxide in producing starches and sugars — by photosynthesis. In the process, they release oxygen. As you can see, plants and animals need each other. The plants and animals don't have to live side by side, since all air contains both oxygen and carbon dioxide.

Like animals, factories also use oxygen and produce carbon dioxide. The oxygen—carbon dioxide cycle is shown in Figure 6-3 below.

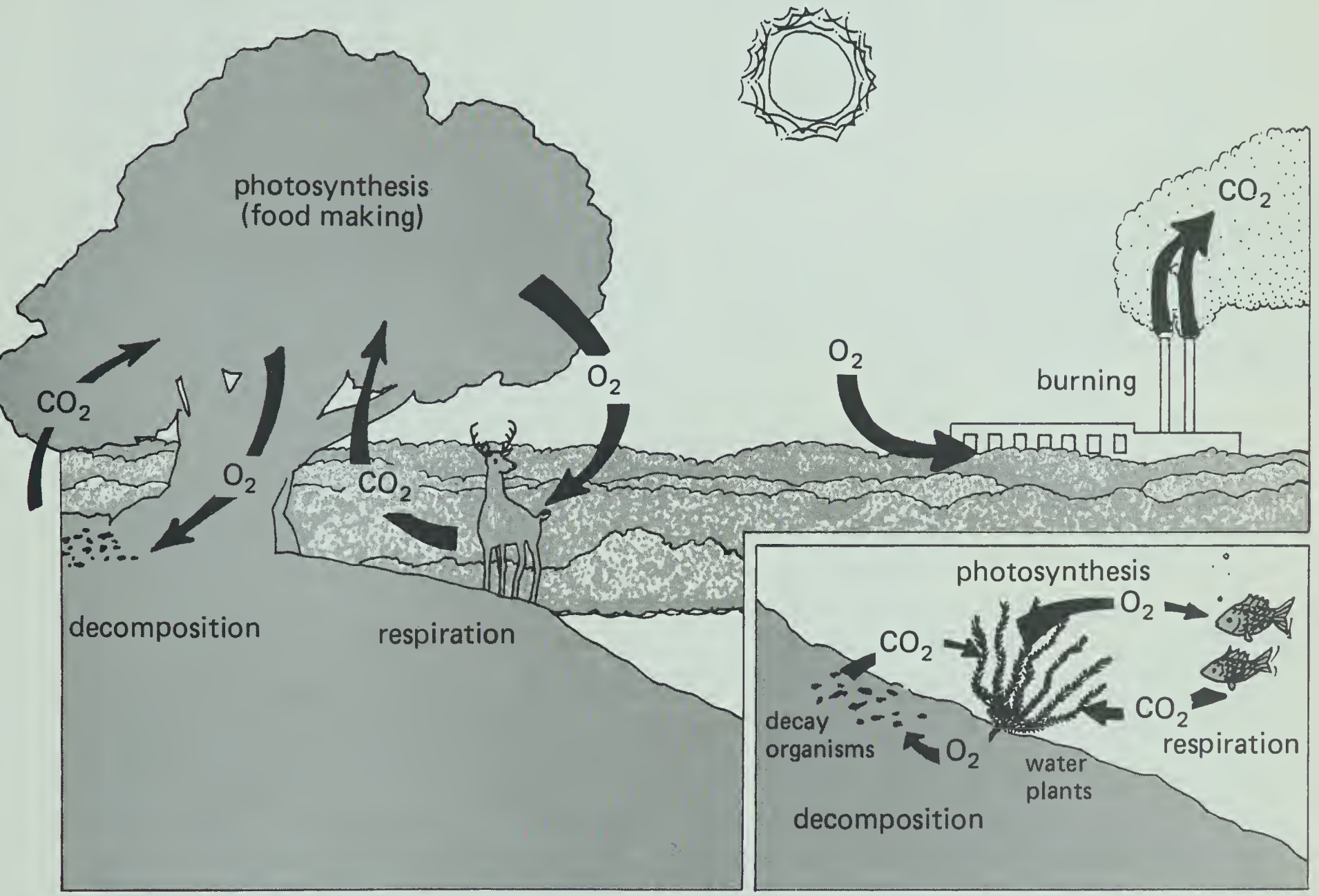


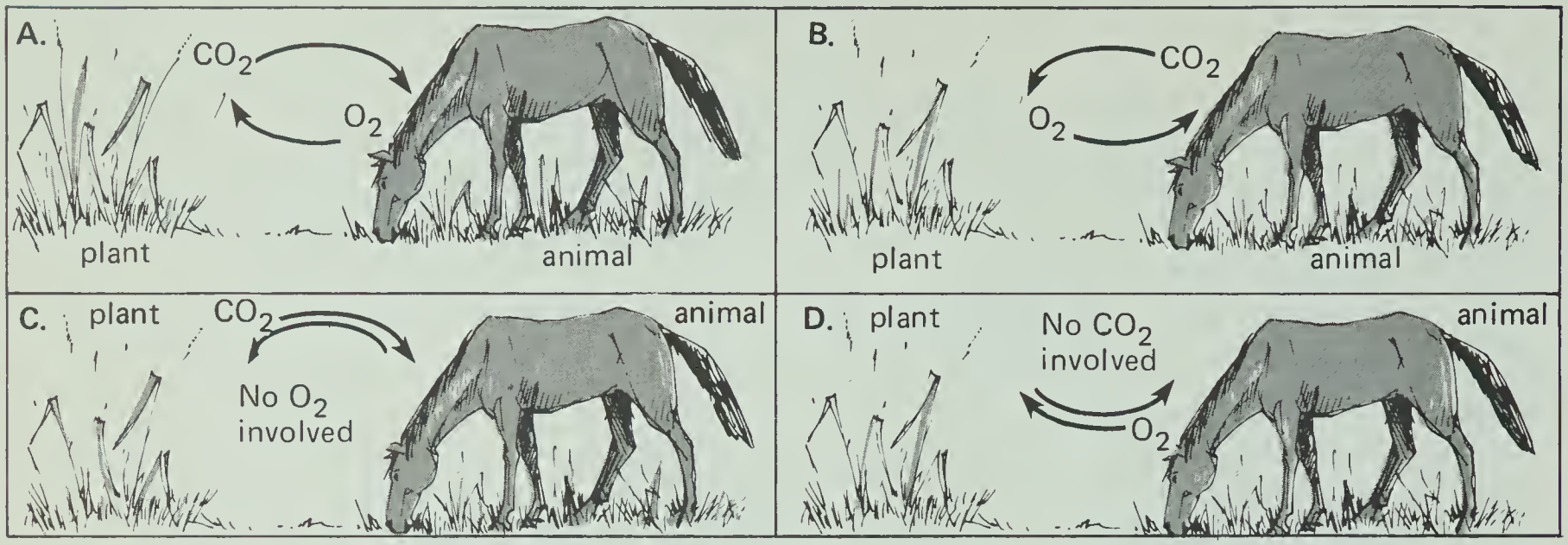
Figure 6-3

6-5. Plants and the atmosphere are sources of oxygen. Animals, combustion from factories, the atmosphere, and decay are sources of carbon dioxide.

- 6-5. Use Figure 6-3 above to name one source of oxygen, O_2, and three sources of carbon dioxide, CO_2.

6-6. B

☆ **6-6. Which of the four diagrams below best describes the main flow of carbon dioxide, CO_2, and oxygen, O_2, between plants and animals?**



Nitrogen is another element that's important to both plants and animals. There is plenty of free nitrogen in the air. But that's not the form that plants can use. However, bacteria "capture" nitrogen in compounded forms called *nitrates*. These nitrates are taken in by plants. Animals get their nitrogen by eating the plants or plant-eating animals. Bacteria also reprocess the nitrogen in animal wastes and in dead plants and animals. Look at Figure 6-4 below. It diagrams the nitrogen cycle.

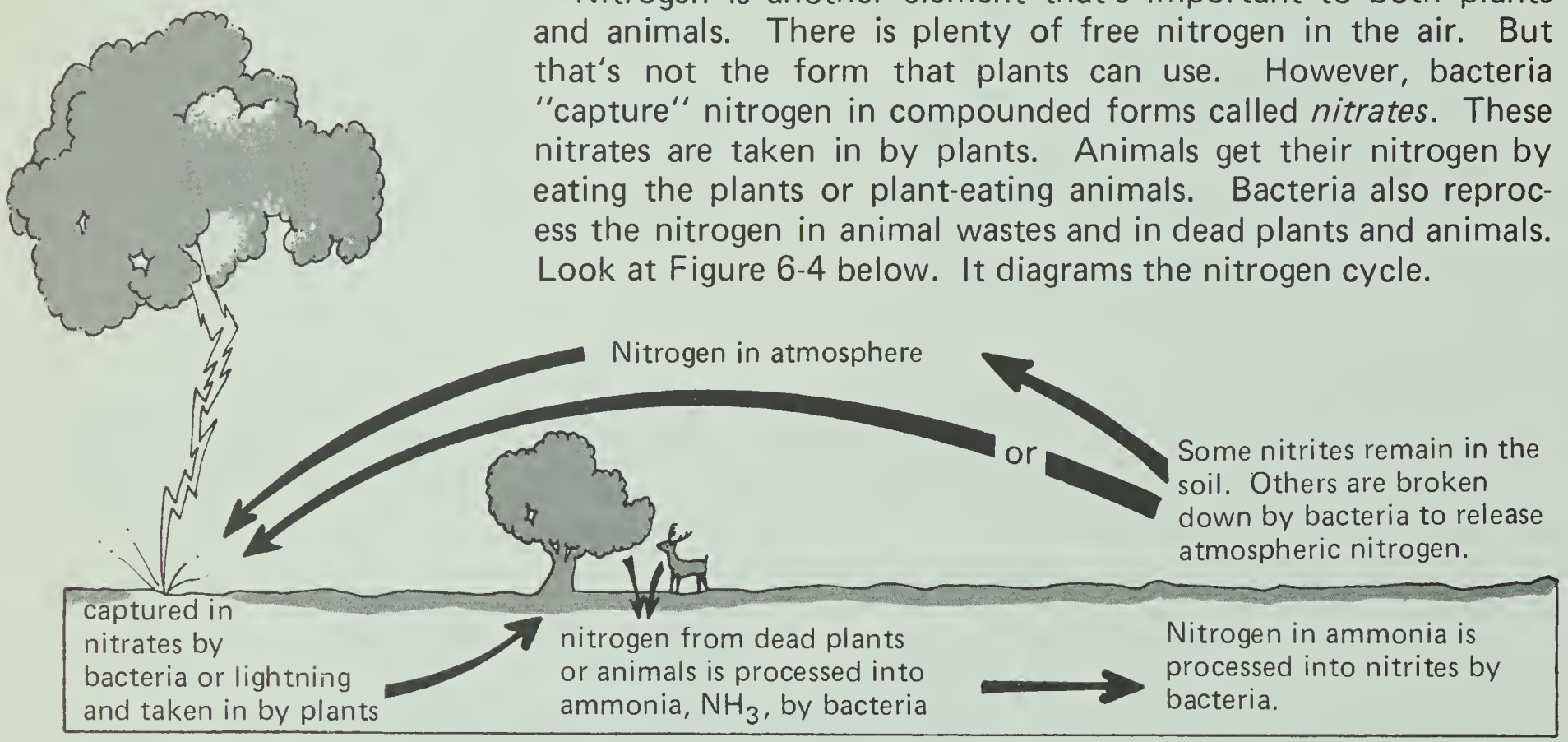

Nitrogen in atmosphere
or
Some nitrites remain in the soil. Others are broken down by bacteria to release atmospheric nitrogen.
captured in nitrates by bacteria or lightning and taken in by plants
nitrogen from dead plants or animals is processed into ammonia, NH_3, by bacteria
Nitrogen in ammonia is processed into nitrites by bacteria.

Figure 6-4

☆ **6-7. Where do plants get the nitrogen they need? Where do animals?**

☆ **6-8. When plants or animals die, what happens to the nitrogen in their bodies?**

6-7. From nitrates in the soil; from eating plants or other animals

6-8. It is processed by bacteria into nitrogen compounds, including nitrates, or into free nitrogen in the atmosphere.

The three big natural cycles (water, oxygen—carbon dioxide, and nitrogen) are always working. They support the life in every community in the *Community Atlas*. All living things depend on those cycles — including you.

ACTIVITY 7: POPULATION UPS AND DOWNS

ACTIVITY EMPHASIS: Five important methods for managing wildlife populations have been developed. Some of them have turned out to have harmful side effects.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter.

A natural *population* is a group of organisms of the same species living in the same local community. The members of a population are able to interbreed. And they compete with one another for food and space.

● 7-1. The blue whales of the Pacific Ocean and the blue whales of the Atlantic Ocean are members of the same species. Why aren't they members of the same population?

7-1. Their local communities are different.

Natural populations can shrink or grow over time. Their size at any particular time results from a combination of population factors. When these factors are in balance, the population may stay the same — even for a long time. Look at Figure 7-1 below.

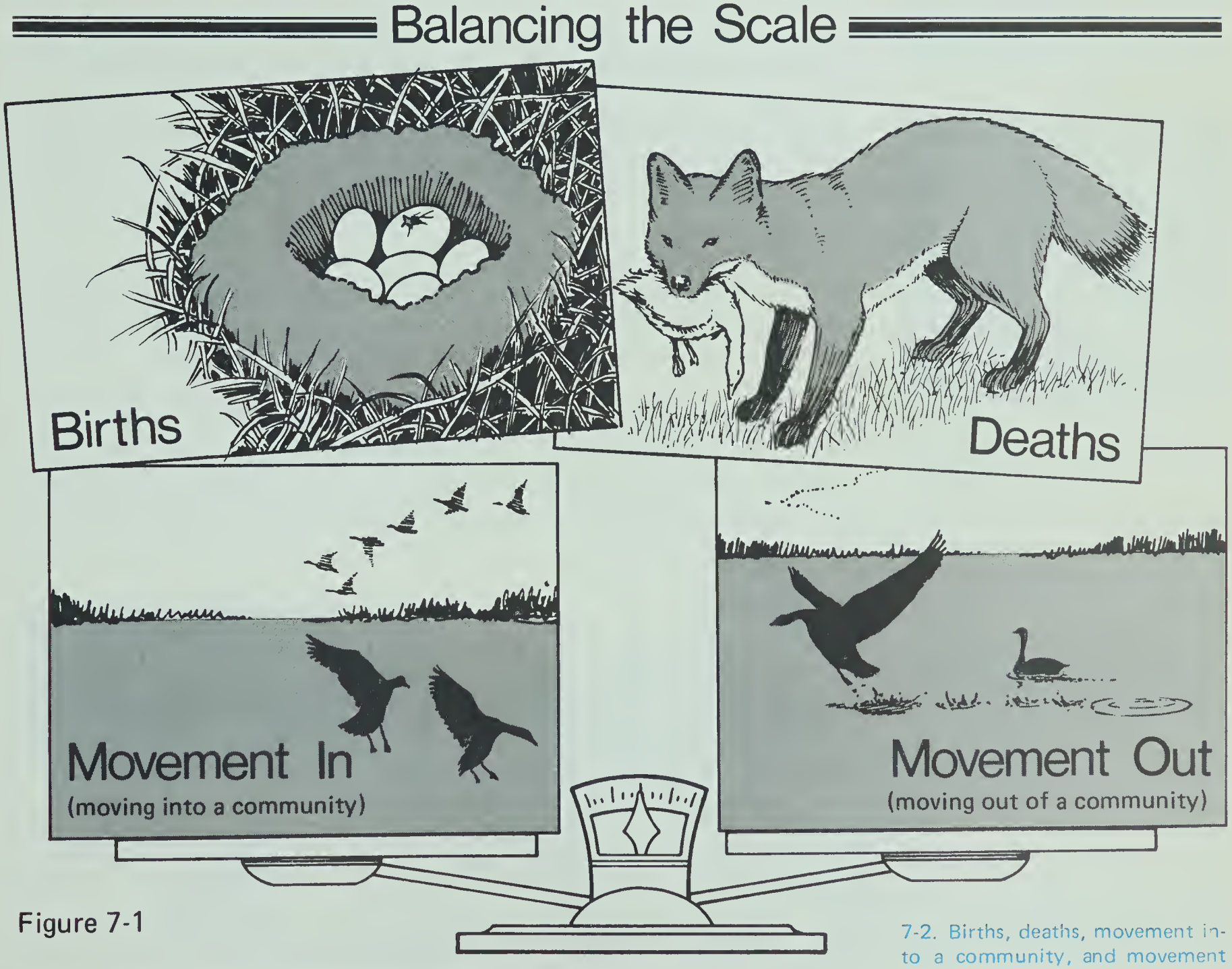


Figure 7-1

7-2. Births, deaths, movement into a community, and movement out of a community

● 7-2. List the four factors that affect population size.

7-3. The population would increase.

7-4. The population would decrease.

7-5. Deaths and movement out of community; decreased population

In places such as wildlife preserves or wilderness areas, populations are often undisturbed. Birthrate, death rate, and movements tend to come into balance. Such populations remain stable unless they're disturbed by outside forces. These disturbing forces include disease epidemics, climate changes, and shifts in the population of predators (animals that hunt other animals). People who are hunters, foresters, and builders can also disturb the natural balance.

- 7-3. Suppose a population's birthrate increased while other factors stayed the same. How would population size be affected?

- 7-4. Suppose movement out of the community increased while other factors stayed the same. How would population size be affected?

About a century ago, there were many millions of bison in the western United States. But the natural balance of the population got upset by hunters and farmers. Hunters killed the bison in large numbers. Farmers cultivated the land and fenced it in. As a result, the bison population fell rapidly. Now there are only a few hundred thousand bison. They live mainly in national parks.

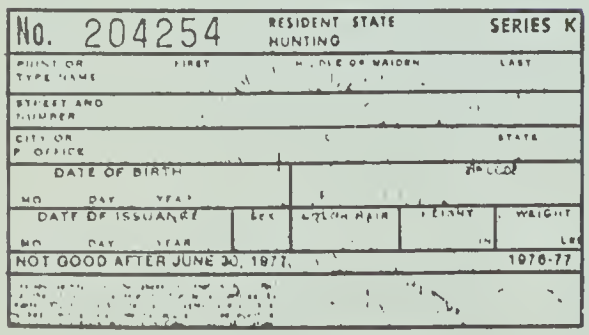
- 7-5. What factors in the natural balance of the bison population were disturbed by hunters and farmers? What was the result?

Government agencies at all levels often try to manage populations of trees and wildlife. They try to protect endangered species and to maintain natural resources for hunting, fishing, and timbering. Many methods are used. Five are described on this page and page 31.

Replenishment can replace lost members of a population. Forests can be replanted. Ponds, lakes, and streams can be restocked with fish. Wildlife can be trapped in overpopulated areas and moved to empty areas.

Hunting and fishing regulations can specify the species, size, sex, and quantity of game taken, as well as the length and timing of the season.

Forestry regulations limit the number, type, and size of trees to be cut.


No. 204254 RESIDENT STATE HUNTING SERIES K

PRINT OR TYPE NAME FIRST MIDDLE OR MAIDEN LAST

STREET AND NUMBER

CITY OR P. OFFICE STATE

DATE OF BIRTH MO DAY YEAR

DATE OF ISSUANCE MO DAY YEAR | SEX | COLOR HAIR | HEIGHT IN | WEIGHT LBS

NOT GOOD AFTER JUNE 30, 1977 1976-77

Predator control can increase a species population size by eliminating or reducing the natural predators of the species. This can backfire, as you'll learn later in this activity.

YOU CAN HELP
PROTECT TWO OF OUR MOST IMPORTANT ENDANGERED BIRDS
Caracara
Bald Eagle
ALL HAWKS, OWLS AND VULTURES ARE PROTECTED BY STATE AND FEDERAL LAWS

Legal protection can be given to *endangered species* — animals or plants whose populations are dangerously small. It's a crime to destroy species on the endangered list.

Game refuges can protect populations from human predators, but not from natural ones.

- 7-6. Each year, in many states, the Game Commission or other agency sets a limit on the number of deer that can be taken (killed) in any locality. Why might a Game Commission raise that limit for a particular year?

7-6. If a game census showed a growing deer population, the limit might be raised to help rebalance the population by temporarily raising the death rate.

- 7-7. Why do you think game refuges are established?

7-7. To provide a safe area for game to live and breed in

- 7-8. In the past, cash bounties have been paid for the killing of wolves, coyotes, foxes, hawks, and certain other species. Why was this done?

7-8. As a means of predator control

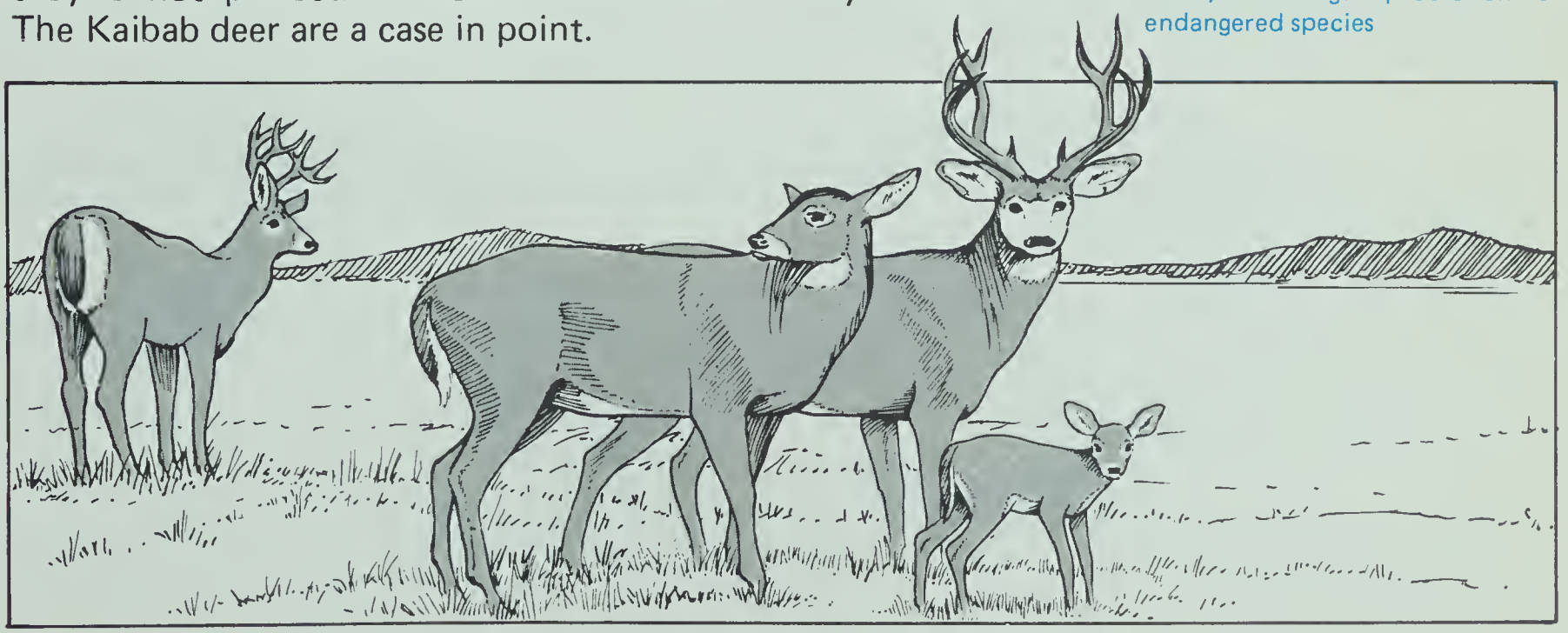
- 7-9. Many ponds and lakes are restocked with game fish every year. What makes this necessary?

7-9. Fishing is too great to allow the native population to grow or even stabilize. The population lost each year must be replaced.

☆ **7-10. Name five common methods used by government agencies to manage natural populations.**

7-10. Regulations (hunting, fishing, forestry), refuge establishment, predator control, replenishment, and legal protection of endangered species

Wildlife management practices are usually effective. But they're not perfect. Unforeseen side effects may cause harm. The Kaibab deer are a case in point.



Early in this century, a healthy but small deer population lived on the Kaibab Plateau near the north rim of the Grand Canyon. They had plenty of food but were regularly hunted by cougars, wolves, and coyotes. These predators kept the deer population down.

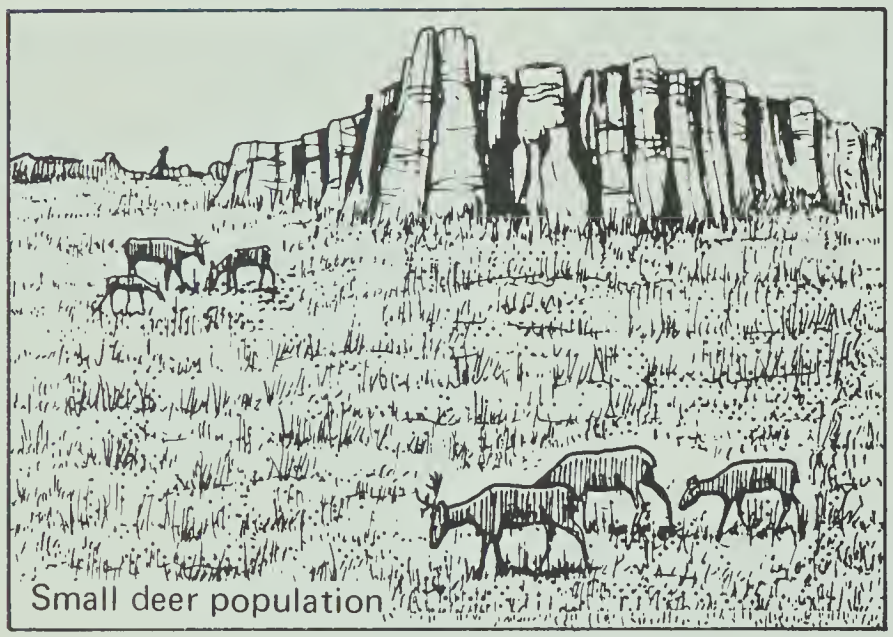
7-11. Births, deaths, movements into the community, and movements out of the community

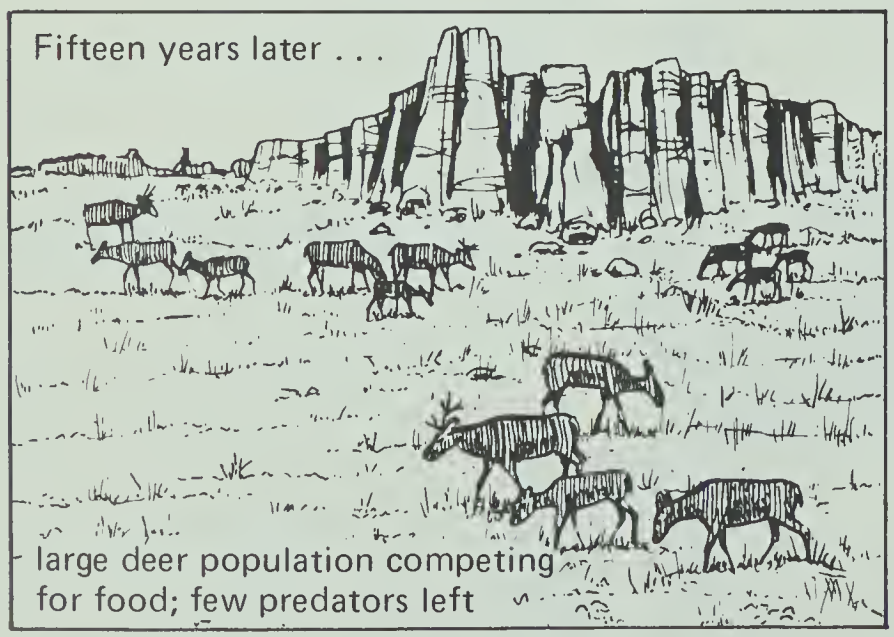
- 7-11. For many years, the Kaibab deer population was stable. What four population factors had to be in balance?

7-12. Cougars, wolves, and coyotes

- 7-12. Name the natural enemies (predators) of the Kaibab deer.

In 1906, President Theodore Roosevelt declared the Kaibab Forest a national game preserve. He wanted to insure that the number of deer increased. Then he would open the area to deer hunters. To allow the deer population to grow, a bounty was declared on the predators. Figure 7-3 below shows what happened.





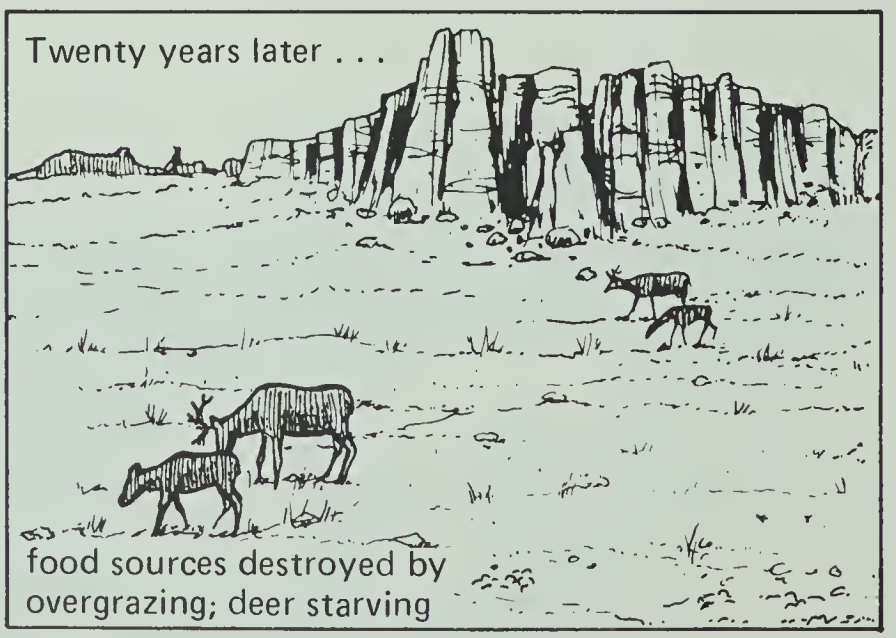


Figure 7-3

● 7-13. When the predators were removed, the Kaibab deer population began to increase. What population factor had changed to cause this increase?

7-13. The death rate was lowered by the absence of predators.

☆ **7-14. Describe the condition of the deer population twenty years after the hunting of predators began. What caused this condition?**

7-14. Deer were starving. Their grazing lands had been ruined by overuse.

Records were kept on the Kaibab deer population from 1907 through 1939. The graph in Figure 7-4 below shows the result of the anti-predator campaign.

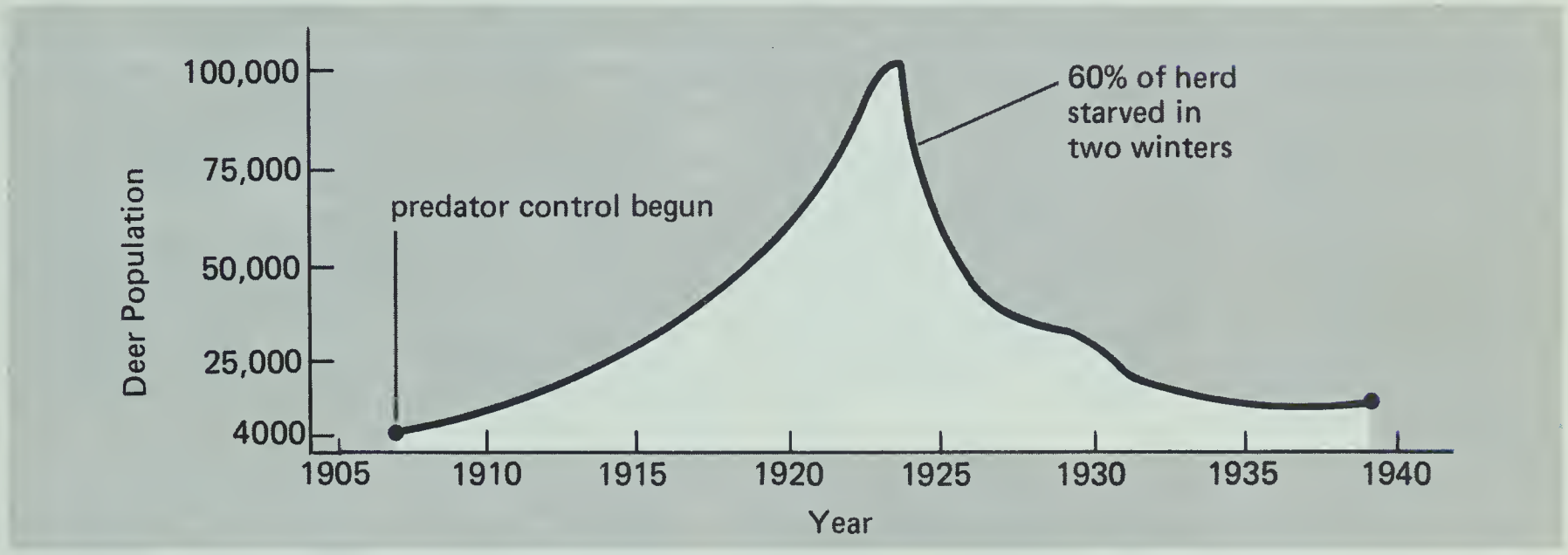


Figure 7-4

Answer the following questions based on the graph in Figure 7-4 above. If you'd like some help using the graph, read "Resource Unit 2: Reading Graphs."

● 7-15. The killing of predators began in 1907. When did the deer population start increasing? When did it start decreasing?

7-15. Almost at once; about 1923

● 7-16. While the deer population was falling rapidly, do you think predators were responsible? Explain your answer.

7-16. No; they had been hunted for many years and were few in number. Starvation cut the herd.

● 7-17. Evaluate the effectiveness of the predator-control program in building the Kaibab deer population.

7-17. The program worked in the short run, and the deer herd grew. But in the long run the program was a failure, since the increase was only temporary.

Although the deer population increased at first, the food supply did not. In fact, it began to decrease. The larger number of deer ate the grass and tree bark faster than it could grow back. This overgrazing damaged the vegetation, killing lots of it. So the food supply decreased even faster. Then many deer starved.

7-18. Shortage of food did. The range couldn't grow enough grass and bark for a large herd.

☆ **7-18. Once the predators were gone, what kept the Kaibab range from supporting a large deer population?**

The Kaibab deer story has an important lesson — predators are important in a community. They hold down the population of their prey, keeping it in balance with available food supplies. Predators usually feed on the weak, old, and sick, so the prey population tends to be healthier overall.

When predators are removed, the natural balance of various populations can be upset in a "chain reaction." When the deer population increases, the grass and shrub populations can be endangered. When these food supplies are reduced, the deer population begins to starve. Furthermore, the loss of grass and shrubs can lead to soil erosion by the action of wind and water.

Finally, predators often hunt more than one species. The loss of predators can mean large increases in the populations of these other species too. The removal of coyotes, for example, encouraged the growth of the rabbit population, as well as of the Kaibab deer population.

7-19. Some things increased (deer and rabbit population). Some things then decreased (grass, shrubs, soil, and finally deer).

☆ **7-19. What unplanned changes in the community resulted when predators were hunted as part of the Kaibab deer population management? (What happened to the community when coyotes were eliminated?)**

7-20. True

☆ **7-20. Tell whether the following statement is true or false. Some methods of wildlife population management may lead to changes in the natural balance, causing unforeseen side effects.**

ACTIVITY 8: WHERE HAVE THEY GONE?

ACTIVITY EMPHASIS: Disturbances of the natural balance have endangered many species and extinguished others. Wildlife management programs have been somewhat successful in protecting endangered species.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

It's a safe bet that you've never seen a live dinosaur or saber-toothed tiger. These creatures have not lived on Earth for many thousands of years. They are extinct.

You've never seen a passenger pigeon either — not even in a zoo. They're extinct too. But they haven't been extinct for thousands of years. The last one died in 1914. Figure 8-1 below shows several species of wildlife that have recently become extinct.

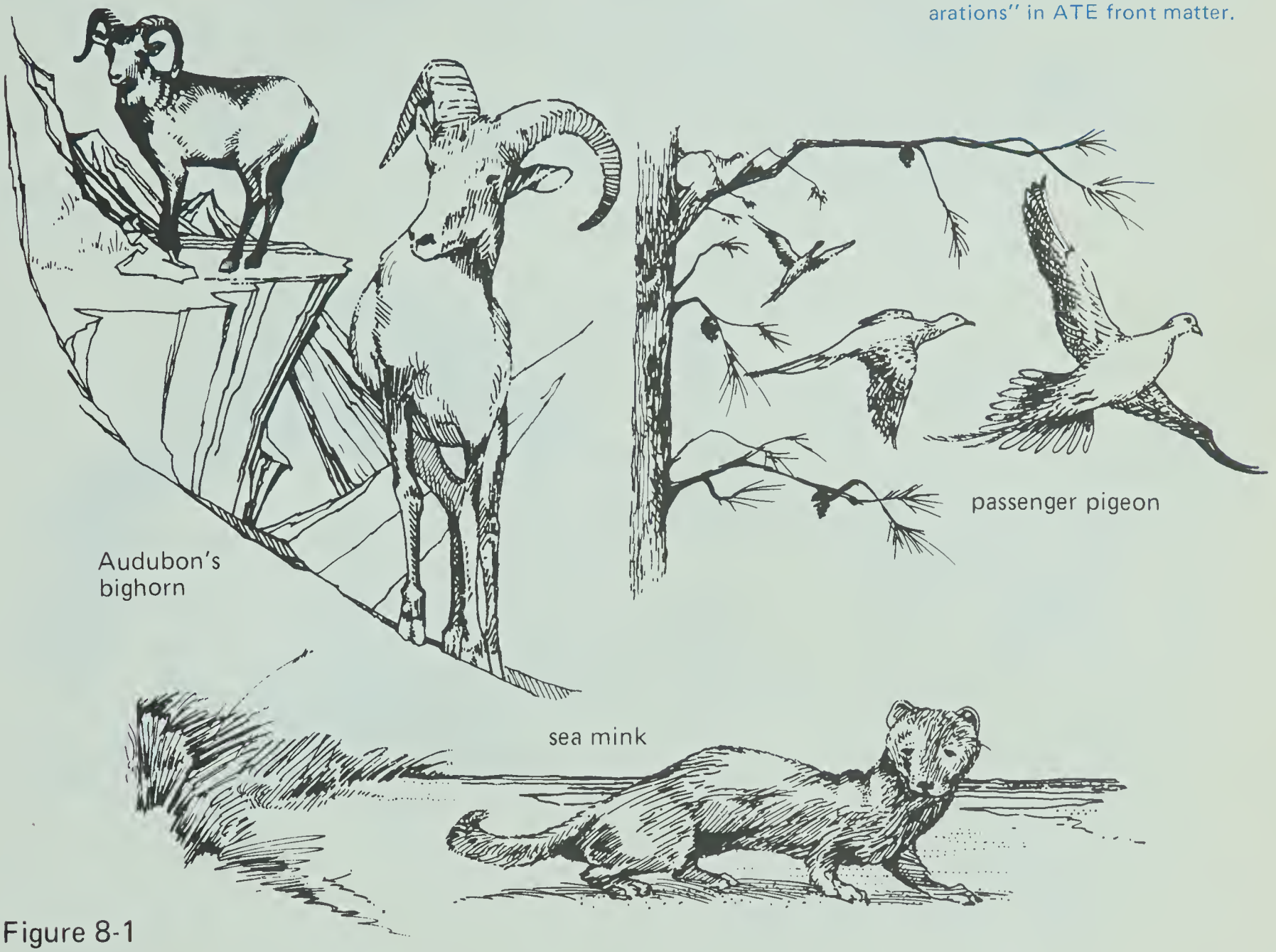


Figure 8-1

● 8-1. The Carolina parakeet is an extinct North American bird. Describe what that means.

8-1. No Carolina parakeets are alive anywhere.

Some species have probably become extinct because of natural changes in the environment. Others have been destroyed by their natural enemies. But a number of species have been extinguished by human action. And many other species are close to extinction.

The species of wildlife shown in Figure 8-2 below are all called *endangered species.* That means there are very few individual members, and they are threatened with extinction.

whooping crane

black-footed ferret

red wolf

Figure 8-2

● 8-2. The Houston toad is an endangered species. What does that mean?

8-2. The number of Houston toads left is small, and they are threatened with extinction.

Human actions have endangered several species of whales. For years, whales have been hunted for the fat deposited in layers under their skin. The fat is boiled to make oil. Figure 8-3 (page 37) shows how the different species of whales have been killed over the years.

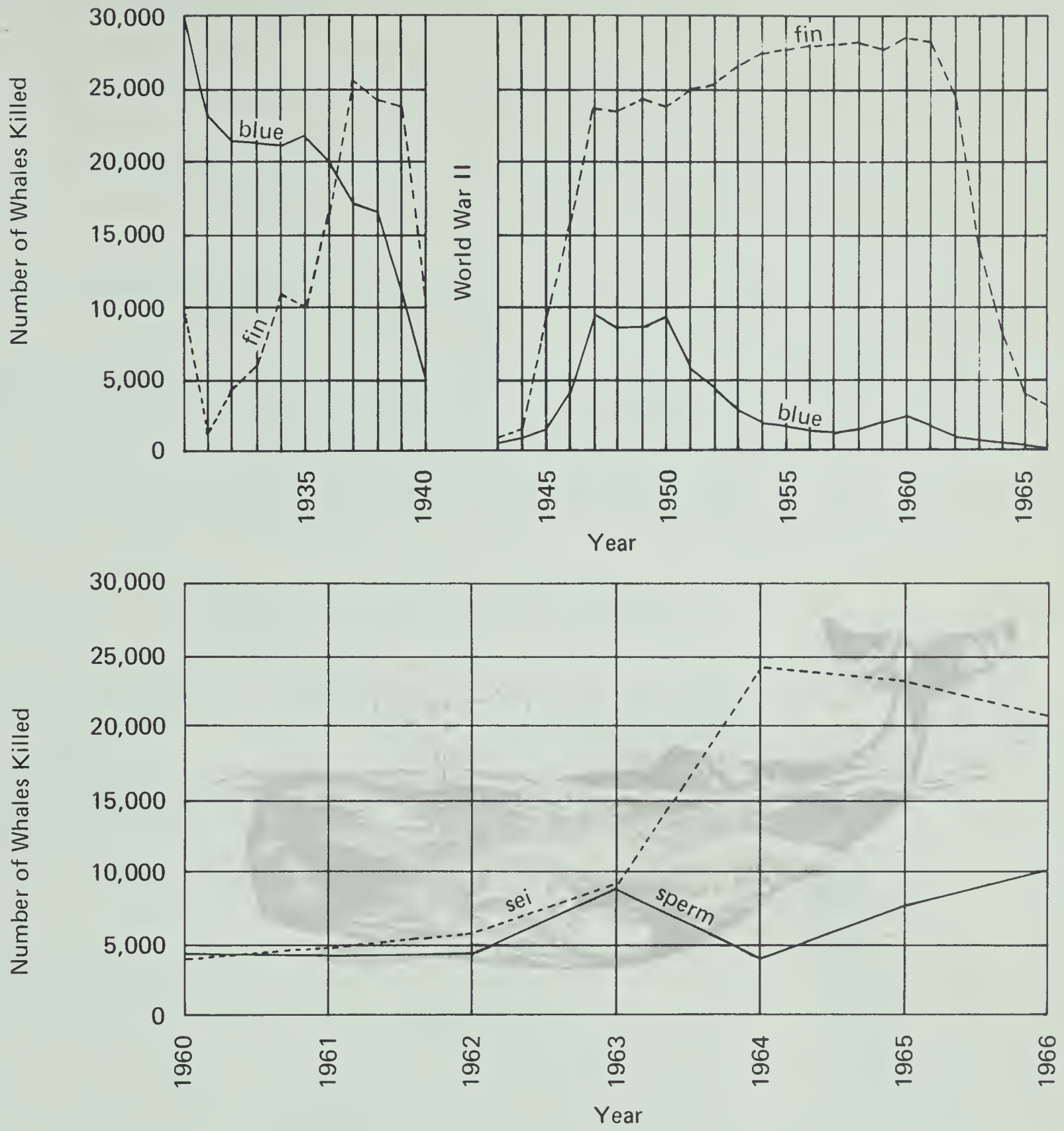


Figure 8-3

First, the whalers hunted mostly blue whales. Blue whales became harder to find in the 1940s, so whalers began to hunt fin whales. When fin whales became scarce, the hunters switched to sei whales. Finally, sperm whales became the target.

Answer the questions on page 38, using the graphs in Figure 8-3 above. If you'd like help understanding those graphs, read "Resource Unit 2: Reading Graphs."

8-3. 30,000; none

8-4. 28,000; 3,000

8-5. 24,000; 21,000

8-6. 8,000; 10,000

8-7. Blue whale none; fin whale none; sei whale about 5,000; sperm whale about 24,000

8-8. Initially, there was a large number of blue whales killed each year. Later, fewer and fewer were killed.

8-9. People (whalers); endangered species

8-10. The extinction of endangered species and the endangerment of other species

● 8-3. How many blue whales were killed by whalers in 1930? In 1966?

● 8-4. How many fin whales were killed in 1960? In 1966?

● 8-5. How many sei whales were killed in 1964? In 1966?

● 8-6. How many sperm whales were killed in 1963? In 1966?

● 8-7. Predict from the graphs the number of each of the four whale types that might have been killed in 1970.

If you had trouble answering Question 8-7 above, read Part B of "Resource Unit 4: Making Graphs." Then try the question again.

Nobody can actually count all whales to determine their population size. But scientists know that whales can't reproduce nearly as fast as the whalers can kill them. So probably the whale populations are decreasing as the whalers hunt them. When a certain species becomes too scarce to be hunted, the population has probably become very small.

☆ **8-8. Look again at Figure 8-3 (page 37). What is the pattern in the number of blue whales killed?**

● 8-9. What is the greatest enemy of whales? Are whales extinct or are they endangered species?

The bald eagle, national symbol of the United States, can still be found in some parts of the country. But it is near extinction. People have invaded almost all of its territory. Bald eagles are now protected by federal law. It is illegal to capture or kill them. This may help to prevent their extinction.

Unrestricted hunting has caused the extinction of some species -- the passenger pigeon, for example. But lots of species have been extinguished or endangered by the loss of their natural habitats. People are taking over more land for houses, highways, factories, and so on. So there's less room for wild animals and plants. Some species die out. One important goal of wildlife management programs is to prevent species extinction and endangerment, whatever the causes.

● 8-10. What are wildlife management programs partly designed to prevent?

ACTIVITY 9: ENVIRONMENTAL CHANGE

People do many different things to the environment they live in. They usually like to change it to meet their needs and wants. Figure 9-1 below shows some ways that people change their physical environment.

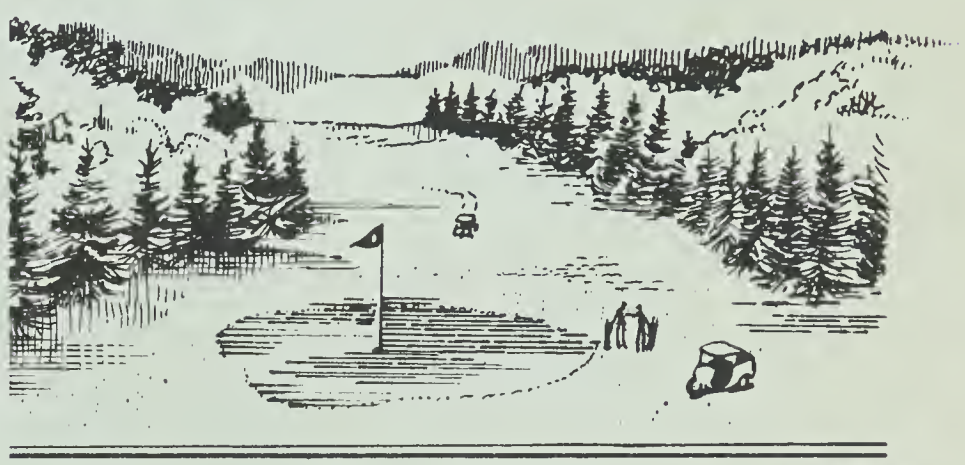
ACTIVITY EMPHASIS: Whenever people make changes in an environment, there are direct and indirect effects on the plants and animals of the area.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

Grasslands before People

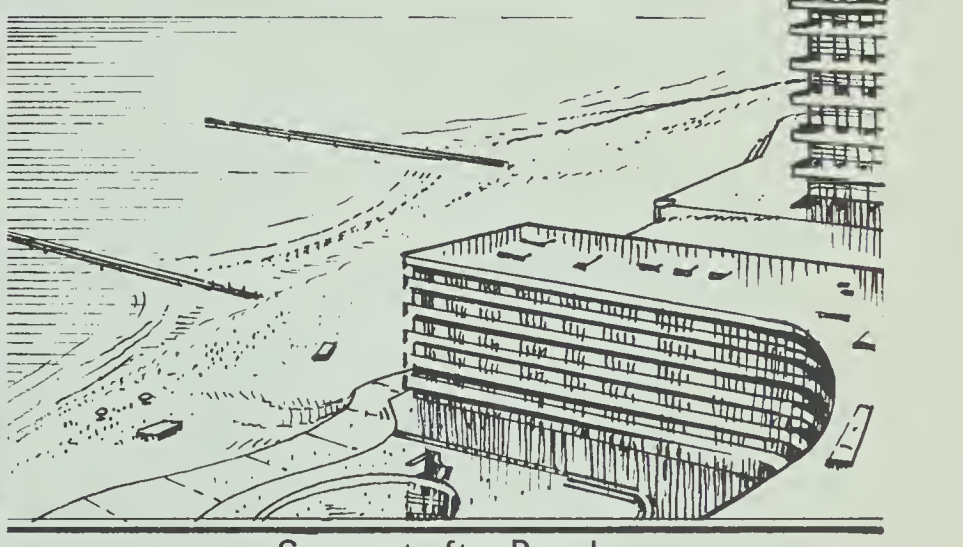
Grasslands after People

Forest before People



Forest after People

Seacoast before People



Seacoast after People

Figure 9-1

● 9-1. According to Figure 9-1 above, what are several ways that people have changed their environment to suit their own needs and wants?

9-1. [Answers will vary. All of the following are acceptable: clearing land for crops and recreation; cutting down trees; reshaping land surfaces; draining swamps and wetlands; building houses and other structures.]

Many environmental changes benefit people. People need adequate food, water supplies, and shelter. But things that benefit people don't necessarily benefit the wild plants and animals in an environment.

9-2. They died or, in the case of animals, moved to another area.

● 9-2. Look again at Figure 9-1 (page 39). What do you suppose happened to the local trees, shrubs, insects, and birds when the golf course was built?

9-3. The burrows were probably destroyed.

● 9-3. Suppose there were four rabbit families living by the seashore. What probably happened to their burrows when the buildings were built there?

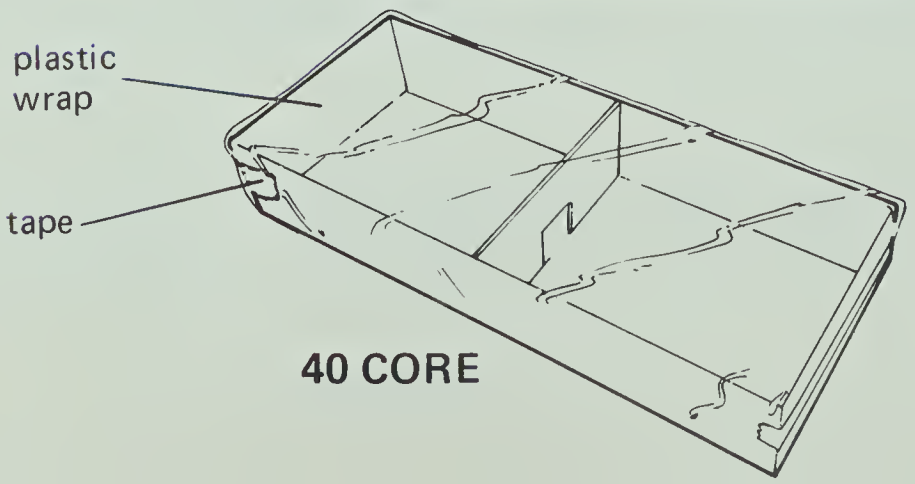
Every species of plant or animal needs to live within certain limits of temperature, light, humidity, and so on. These limits define the organism's *range of tolerance*. If environmental conditions go outside the range of tolerance, the organism can't survive. So when conditions begin to approach a tolerance limit, most animals will move. They will look for a more suitable, mid-range environment.

9-4. They probably moved out or were killed.

● 9-4. When farmers first began plowing the wild prairie grasslands, what do you think the local animals did?

Here's an investigation about animals' responses to environmental change. In this investigation, you'll prepare and use a choice chamber. It lets you see the way animals react to temperature differences. You'll need about thirty minutes today and about twenty minutes tomorrow. You'll also need the following materials.

choice chamber
plastic wrap, 30 cm X 60 cm
masking tape
2 large (1-gallon) plastic milk jugs, precut
sources of hot and cold water
Celsius thermometer
6 small animals of one type
scissors
black cloth to cover chamber

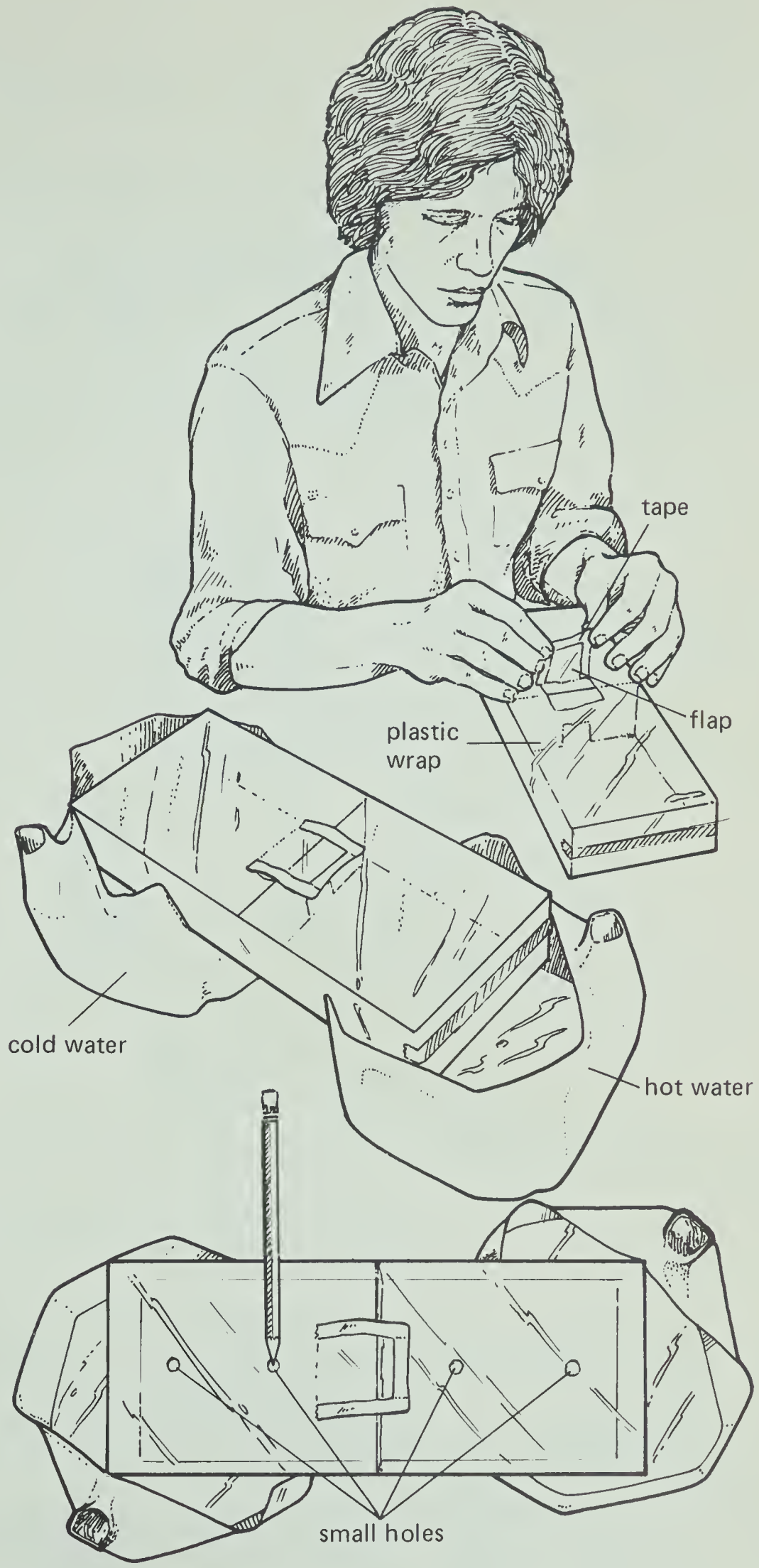


A. Get the choice chamber, and remove the plastic lid. Tape the plastic wrap tightly over the chamber opening.

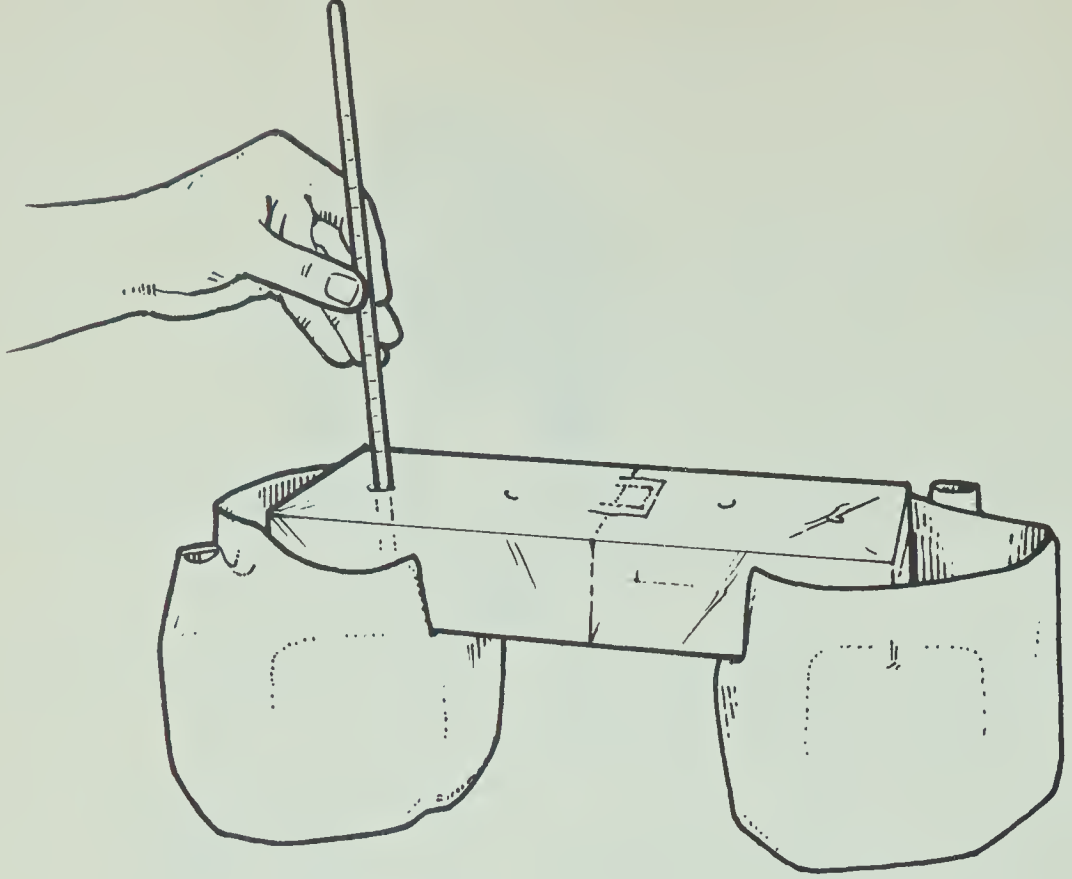
B. Use the scissors to cut a small opening flap in the plastic wrap. Cut it on three sides, directly over the passageway in the choice chamber. Fold a piece of masking tape over the three cut edges of the flap. That will make it easier to lift the flap. And it will keep the flap from dropping into the chamber. Your animals will be put through this opening when you get to Step E.

C. Put hot water into one plastic-jug holder. Put cold water into the other holder. The water should come to about 1 cm below the openings in the holders. Set the choice chamber in the holders, as shown.

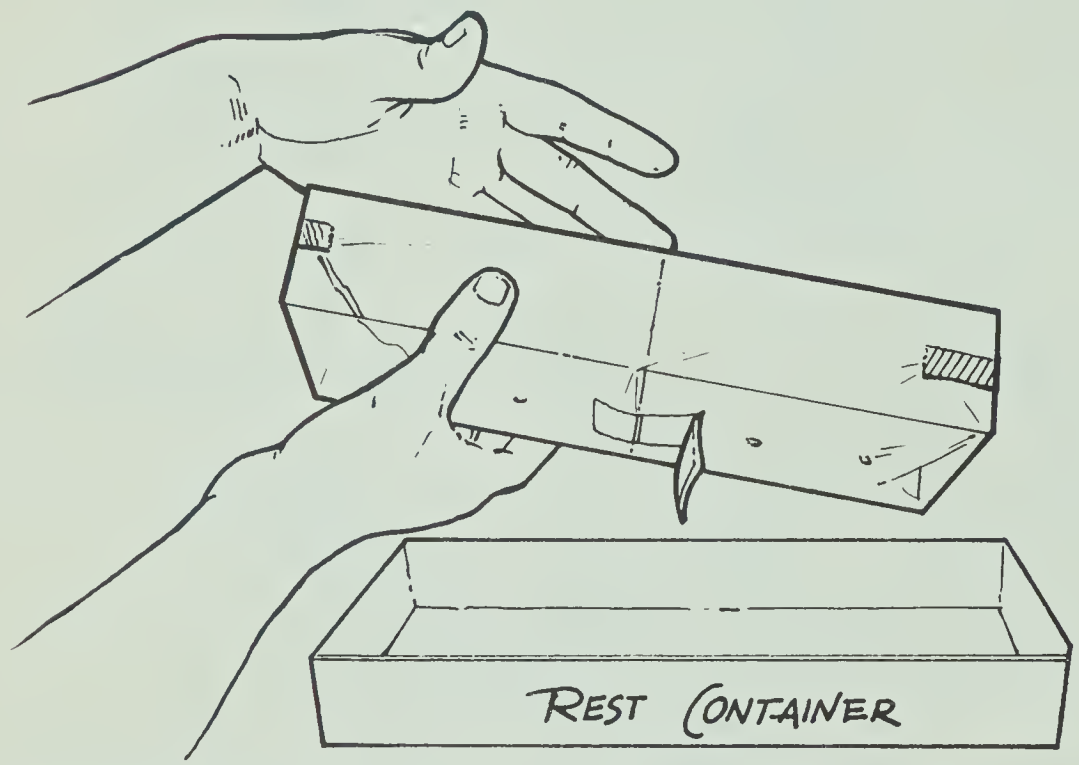
D. With a sharp pencil, punch four small holes in the plastic wrap, spaced as shown. The thermometer will be put into the holes to take temperature readings.



If you're not sure how to measure temperature, read "Resource Unit 14: Using a Thermometer" now. Then do Step E.



E. Measure the temperature of the chamber, first at the cold end and then at the hot end. Keep checking until the temperature difference between the two ends is more than ten degrees. Then put three of the small animals into the chamber through the flap opening. Close the flap.



F. Observe the behavior of the animals for about 15 minutes. When you're finished with them, return your animals to the rest container provided by your teacher. The same animals shouldn't be used again for a day.

9-5. [Answers will vary, but the animals probably moved in one direction.]

9-6. [Answers will vary.]

9-7. You can't be sure; some other factor may have had an effect.

9-8. Doing the investigation in the organism's natural environment would be one way. Or, if another factor is suspected, you could try another investigation. This time, you should change the suspect factor and keep the other conditions constant.

- 9-5. What did your animals do?

- 9-6. Did the animals stop in one place? If so, what was the approximate temperature of that place?

You've tried to control all the factors of your animals' environment except one — temperature. But it's hard to be sure that temperature alone caused the observed behavior. Light, gravity, moisture, or some other factor may have had some effect. Remember, the choice chamber is not a natural environment.

- 9-7. How can you be sure that your animal subjects were responding only to temperature? Explain your answer.

- 9-8. How could you check your answer to Question 9-7 above?

If you had trouble answering Question 9-8 on page 42, read "Resource Unit 15: A, B, C's of Experimenting." Then try to answer Question 9-8 again.

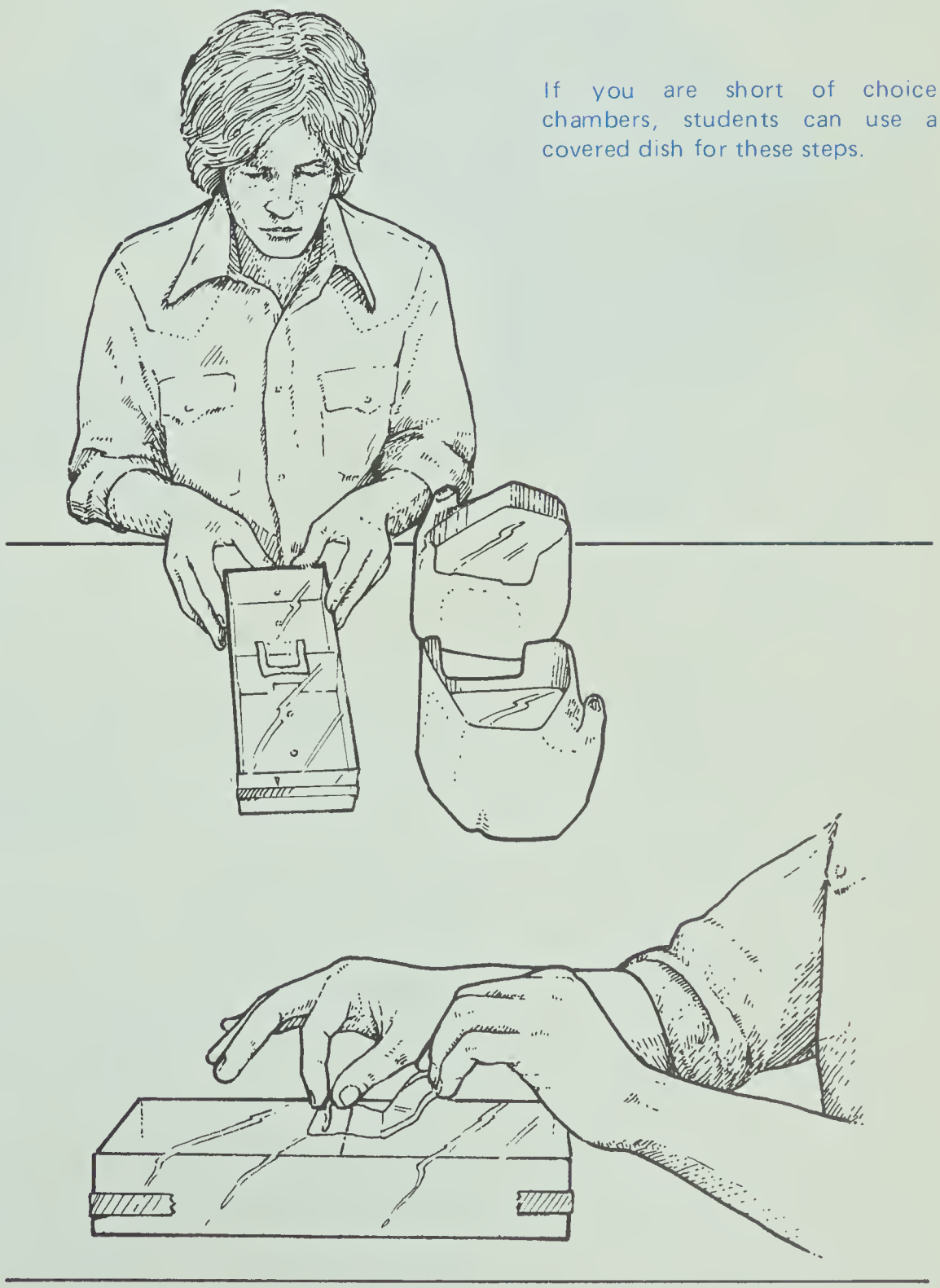
You probably observed in your investigation that the animals sought out a medium temperature. They tried to avoid extremes. In nature, these animals live best in moderate conditions. They prefer to be underground, under a log, or in some other cool place.

● 9-9. Suppose your subject animals were living in their natural environment and people destroyed it. What would the animals do if suddenly exposed to the hot sun?

9-9. They would seek a cooler, darker place or possibly die.

G. Separate the choice chamber from the hot and cold water stands. Let the temperature equalize throughout the chamber.

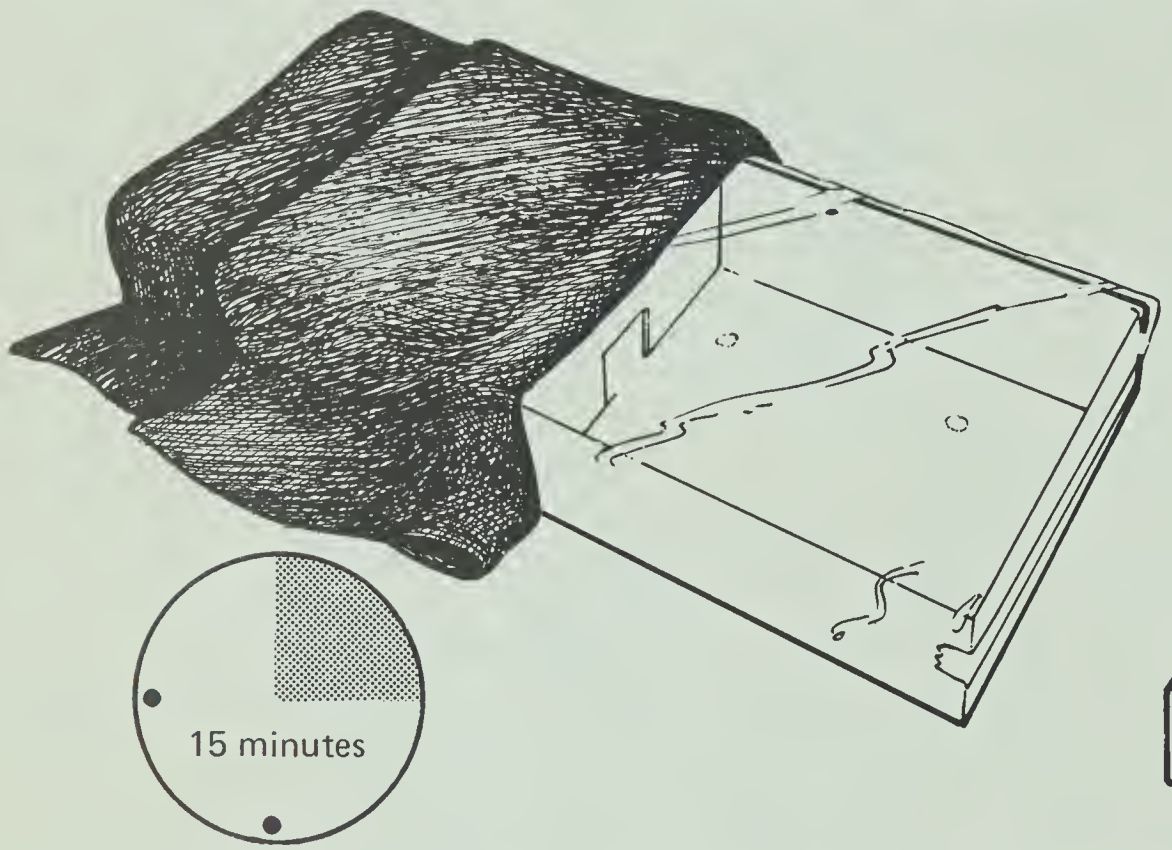
If you are short of choice chambers, students can use a covered dish for these steps.



H. When the whole chamber is at room temperature, place the remaining three animals in it through the flap opening.

I. Cover the chamber with the black cloth. Store it safely overnight.

THE NEXT DAY



J. Carefully fold back the black cloth from one-half of the choice chamber. Observe the animals' behavior for about 15 minutes. Then place these animals in the rest container.

9-10. The ones in the dark stayed there; the ones exposed to the light moved to the darkness.

9-11. They move to where conditions are better — another dimly lit forested area.

● 9-10. When you exposed half the chamber to light, how did the animals respond?

● 9-11. During the clearing of forest land, organisms living on the forest floor or underground may be exposed to bright sunlight. What do you suppose these organisms do?

The building of reservoirs, housing developments, and industrial parks can destroy nearby plant and animal life. Too often, planners have ignored the environmental impact of construction. Unless the whole ecological balance is taken into account, the results can be disastrous.

Figure 9-2 on the left of page 45 shows an area before a dam was constructed. Figure 9-3 on the right of page 45 shows the same area after construction.

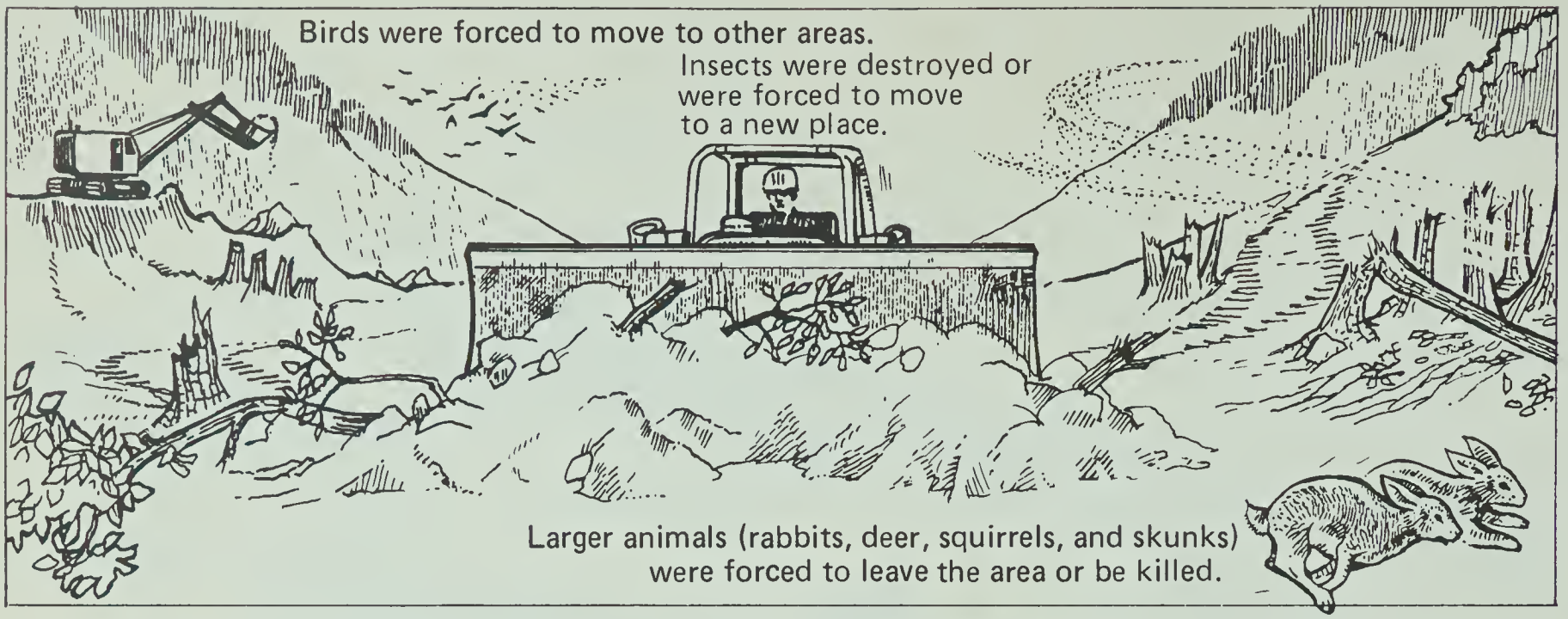
Figure 9-2

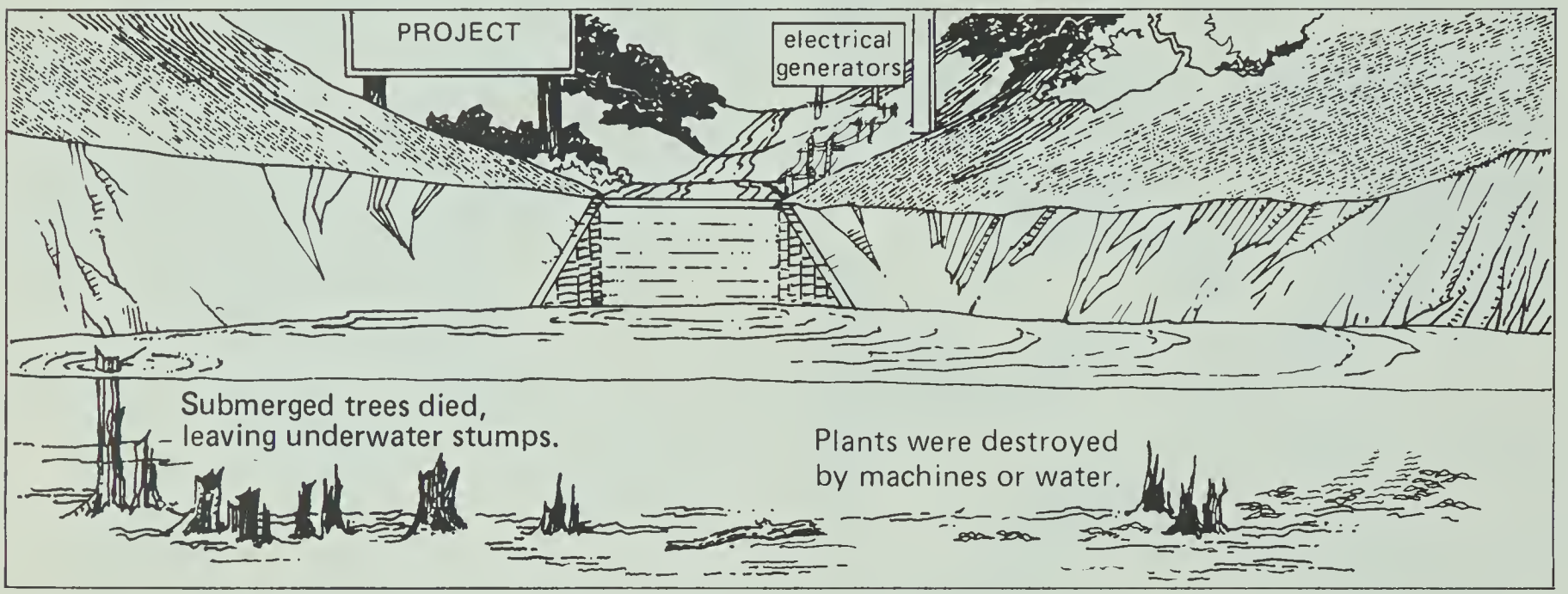
Figure 9-3

● 9-12. The dam construction shown in Figure 9-3 above affected the river's speed. Did the river flow faster or slower? The undammed river was a moving freshwater habitat. What type of habitat is the reservoir formed by the dam?

9-12. Slower; standing fresh water

Dams are constructed in drainage basins — streams or valleys — between hills or mountains. Consider what resulted from the construction of the dam shown in Figure 9-3 above. Some of the effects are shown in Figure 9-4 (page 46).


Birds were forced to move to other areas.
Insects were destroyed or were forced to move to a new place.
Larger animals (rabbits, deer, squirrels, and skunks) were forced to leave the area or be killed.


PROJECT
electrical generators
Submerged trees died, leaving underwater stumps.
Plants were destroyed by machines or water.

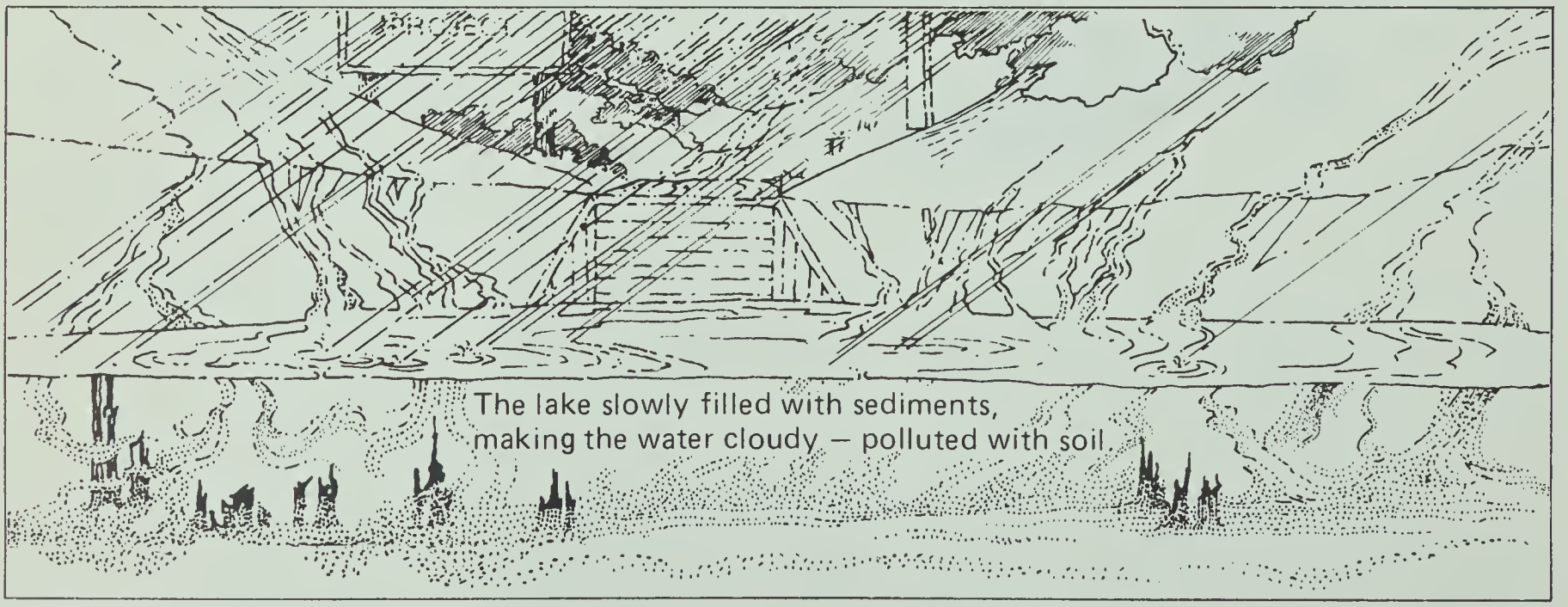

The lake slowly filled with sediments, making the water cloudy – polluted with soil.

Figure 9-4

• 9-13. The dam provides some desirable things for people. What are they? (Hint: See Figure 9-3 page 45.)

9-13. Recreation, electrical power, flood control, and water supplies for human use and irrigation

• 9-14. What are two reasons that birds had to move to another area after the dam was built?

9-14. Trees in which birds built nests were gone. Plants and insects upon which birds fed were gone.

• 9-15. The building of the dam caused many animals to move to other areas. How do you think this affected the food supply for animals already living in those areas?

9-15. The food supply was reduced by the influx of animals from the construction area.

☆ **9-16. How are the homes and food supplies of wildlife populations affected when a dam is built?**

9-16. Homes and food supplies of wildlife are destroyed and food supplies of nearby wildlife populations are reduced by the influx of animals from the construction area.

ACTIVITY 10: A FIELD TRIP (REQUIRED)

ACTIVITY EMPHASIS: A field trip allows students to observe firsthand many different plants, animals, and conditions of local communities. The activity will help students to summarize content and concepts of the core activities.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

To complete the core activities, you are going to take a field trip into an actual community. There you will have the chance to observe plants and animals firsthand. You can see some examples of things you've been learning about in the core. Check with your teacher about the arrangements for the field trip.

To prepare for the trip, study the plate in the *Atlas* for the community you plan to visit. Make a list of the principal organisms that live in that type of community.

Dress appropriately for the type of weather, and wear walking shoes. You'll need a notebook and pencil to record your observations. If you have a camera, field glasses, or a hand lens, take these things with you.

CAUTION	All environments have hazards. People get thirsty and badly sunburned on deserts. People drown in lakes, streams, and oceans. People get lost in forests. Be very careful!

The purpose of your field trip is to observe and study a local community. Plates in the *Community Atlas* have given you only a secondhand view. Try to see as much as you can. Make notes and sketches in your notebook. Leave the plants and animals in the community as nearly undisturbed as possible.

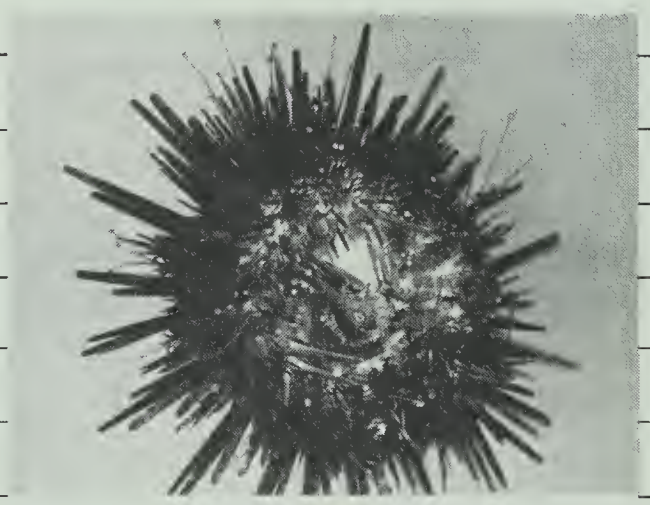
If you have a camera, take some pictures. If you have a hand lens or field glasses, use them in making your observations and sketches.

When you return, prepare a short report of your trip. It should include answers to the following questions.

1. Which community did you visit?
2. How many plants listed on the plate of the community you visited did you actually observe? Name them.
3. Name the members of the predator–prey relationships that you observed.
4. Name the members of any food chains you observed.
5. Name any decomposers you observed, and describe the habitats in which you observed them.
6. Did you observe any examples of special adaptations of plants or animals to their environment? If so, name the plants or animals and describe the adaptations.
7. Did you observe any examples of the effects of the "Special Features" on the plants and animals? If so, describe them.
8. Did you see any evidence of human control of wildlife populations?

You made some sketches or took photographs of plants and animals you observed on your field trip. For each plant and animal you sketched or photographed, make a specimen card like the one shown in Figure 10-1 below. Include all the information shown on that card.

Name: SEA URCHIN Community: Seashore (in tide pool)



Geographic location: Beach near Mobile, Alabama

Notes: Found among seaweed; sharp spines; about 8 cm in diameter; purple color

Figure 10-1

When you finish writing your report and filling out your specimen cards, give these things to your teacher.

Advanced

ACTIVITY 11: PLANNING

If you plan to do Activity 12, start it as soon as you finish this planning activity. Then, you can work on other activities while collecting data.

Activity 12 Page 50

Objective 12-1: Design an experiment to study the effects of various temperatures, amounts of moisture, or amounts of light on seed germination.

Sample Question: Suppose you want to find out how light affects radish seed germination. You plant twenty radish seeds in each of two pots at equal depths (5 mm) in the same kind of soil. You add the same amount of water to each pot each day. Which of the following is necessary to complete the experiment?

A. Add fertilizer to one pot, but not to the other.
B. Add a third pot with no seeds as a control.
C. Put both pots in a dark cabinet.
D. Keep one pot in the dark and the other in the light.

Activity 13 Page 54

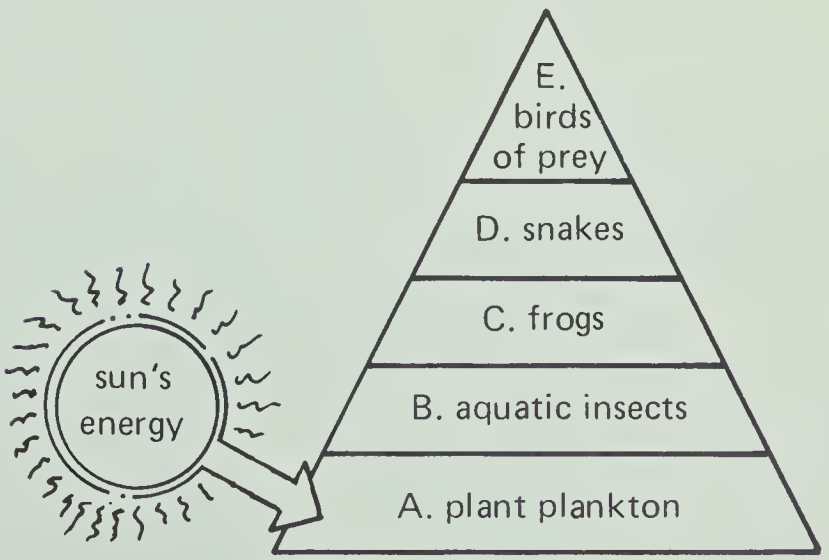
Objective 13-1: Identify, in order, the six principal stages of biological succession from a standing freshwater community to a forest community.

Sample Question: Which of the letters in the diagram below indicates the climax stage of succession from a standing freshwater community to a forest community?

Activity 14 Page 60

Objective 14-1: Describe the transfer of energy through a common food pyramid.

Sample Question: Which level of the food pyramid shown below contains the most stored energy?



Answers: 12-1. D, **13-1.** A, **14-1.** A

ACTIVITY EMPHASIS: An experiment to test the most suitable temperature, light, or moisture conditions for the highest rate of radish seed germination includes formulation of a hypothesis and testing of germination, using one of those variables.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

Using seed germination trays will cut out some of the listed equipment.

ACTIVITY 12: GERMINATION AND YOUR DESIGN

To germinate, a seed needs certain growing conditions. You probably know that moisture and proper temperature are important for seeds. So are other factors, such as light, soil, and nutrients.

In this activity, you'll design an experiment to determine the conditions of temperature or of light or of moisture in which the highest number of radish seeds will germinate. To complete this investigation, you'll need about four days and the following materials.

30 radish seeds
3 baby-food jars with lids
distilled water in dropping bottle
50-ml graduated cylinder
grease pencil
2 paper towels
3 shoe boxes with lids

If you plan to vary the moisture, you'll need 3 heavy, dark plastic bags, too.

If your test variable is light, you'll need these items, too.

A drawer can be used to provide darkness.

heavy, dark plastic bag
2 clear plastic bags
electric lamp

If the variable you plan to test is temperature, your additional materials will include the following.

refrigerator with a range from 5°C to 10°C
incubator with a range from 45°C to 50°C
thermometer
3 heavy, dark plastic bags

MOISTURE	LIGHT	TEMPERATURE
wet conditions (20 ml of water)	present (24 hours of electric light)	5°C to 10°C (cold, in refrigerator)
moist conditions (5 ml of water)	present (natural light during day)	20°C to 30°C (room temperature)
dry conditions (no water)	absent (total darkness)	45°C to 50°C (hot, in incubator)

A. Select one of the three factors — temperature, light, or moisture — and design an experiment. Examine these levels suggested for the three factors. You may use these suggestions or choose your own levels.

● 12-1. Which physical factor — temperature, light, or moisture — do you plan to design your experiment to test?

If you are not sure how to design an experiment, read "Resource Unit 15: A, B, C's of Experimenting." It can help you.

● 12-2. State the hypothesis you plan to test in your experiment.

● 12-3. What is the variable you plan to test? How will the variable be tested?

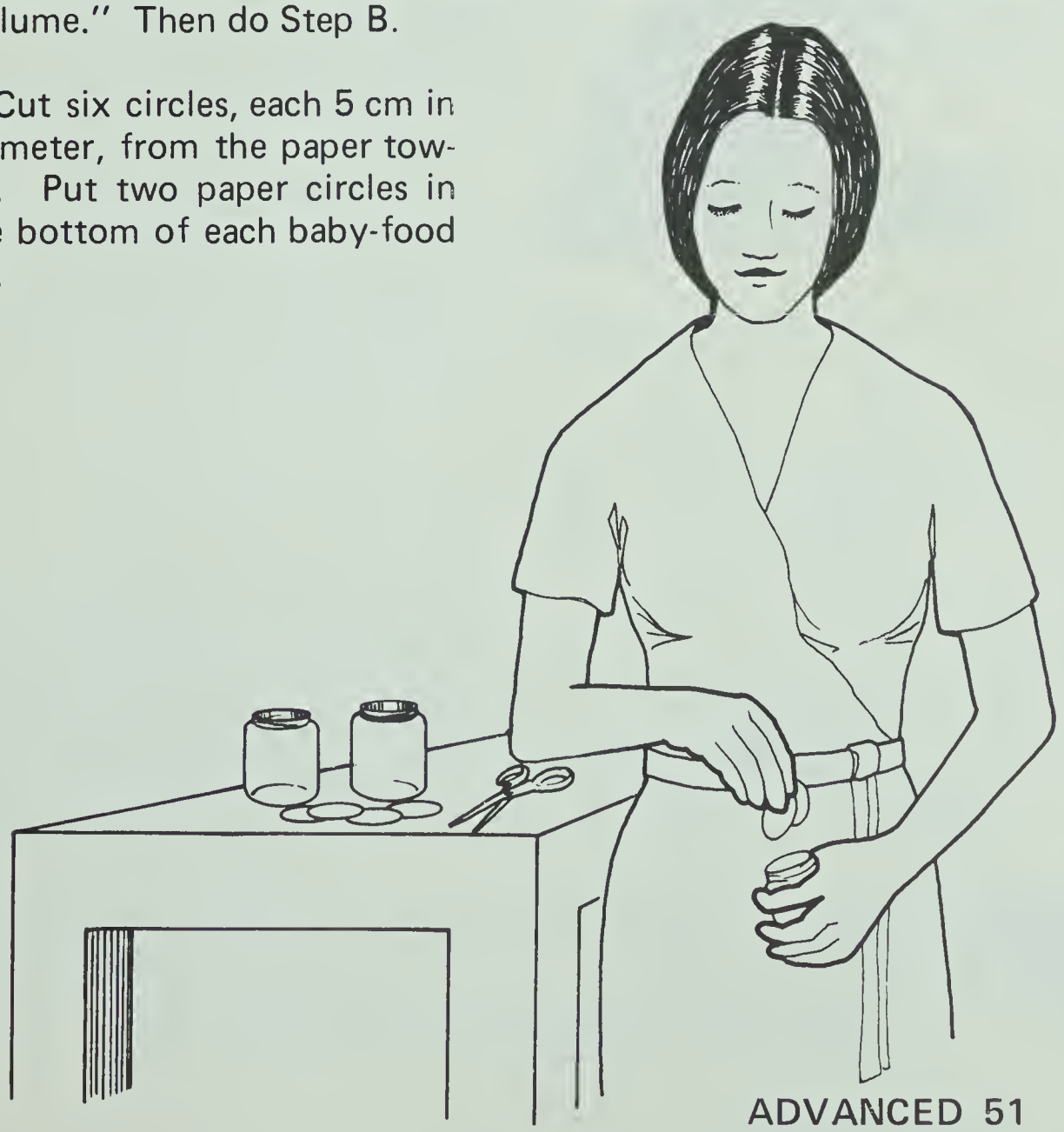
● 12-4. What variables will you control? How do you plan to control these?

● 12-5. What data do you plan to collect?

● 12-6. How will you determine whether your hypothesis is supported by the data?

Now set up the materials for your experiment. If you're not sure how to measure volume, read "Resource Unit 5: Measuring Volume." Then do Step B.

B. Cut six circles, each 5 cm in diameter, from the paper towels. Put two paper circles in the bottom of each baby-food jar.



12-1. [Answers will vary. You may wish to encourage different lab groups to select different factors to test.]

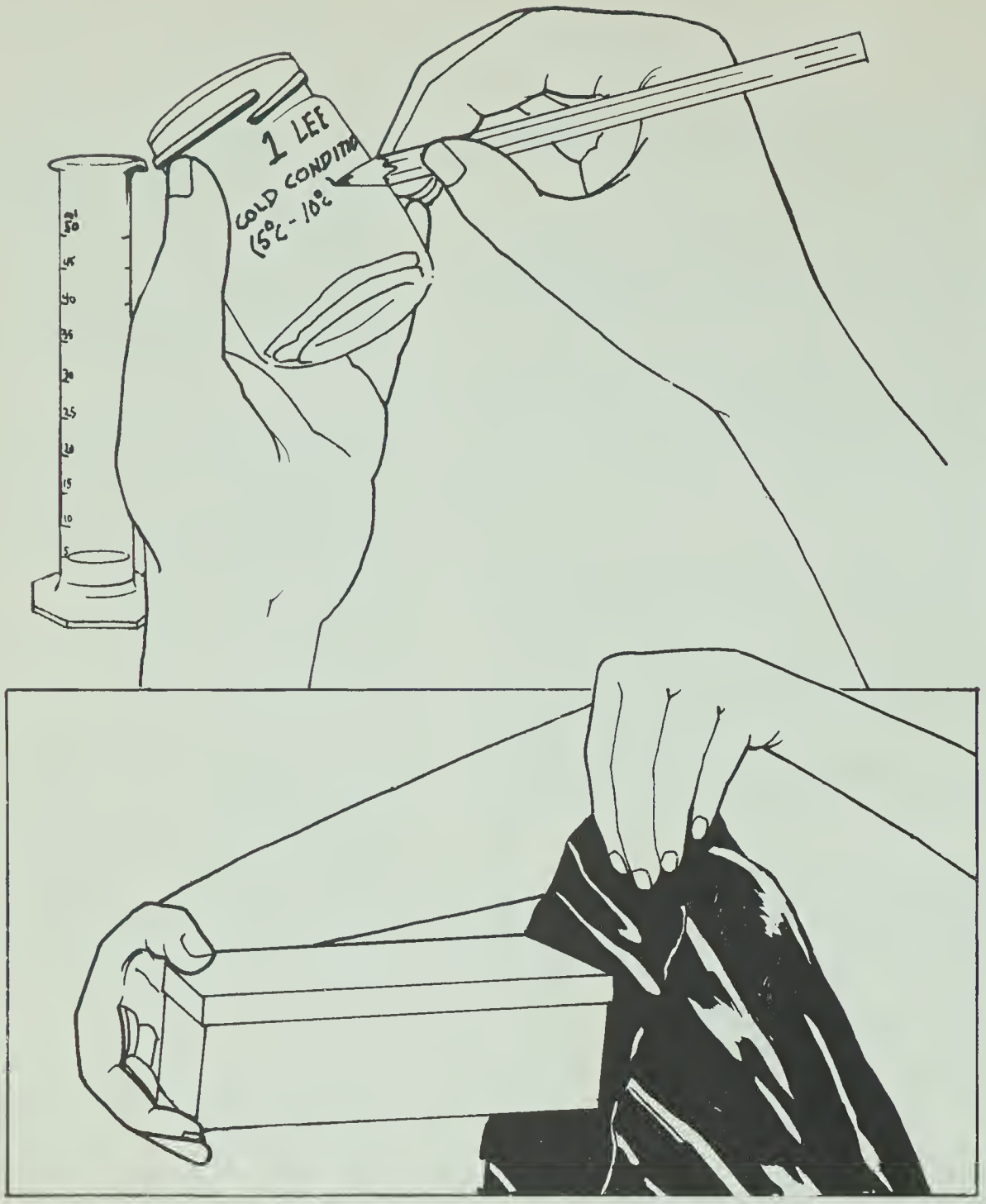
12-2. [Answers will vary, but they should be consistent with the choice of the physical factor.]

12-3. [Answers will vary, but they should be consistent with the design of the experiment.]

12-4. [Answers will vary, but they should be consistent with the answer to Question 12-3.]

12-5. The number of seeds that germinated

12-6. [Using such extremes as those suggested should provide marked differences in numbers of germinated radish seeds so that students can reach a conclusion without difficulty. Some students may need help interpreting their data in relation to their hypothesis.]



C. Label each jar and each plastic bag with your name and the condition that the jar will be under. Put 10 radish seeds on the paper circles in each baby-food jar.

D. If you are not testing for moisture, add 5 ml of water to each jar. If you are testing for moisture, add the proper amounts of water to two jars and no water to the third jar.

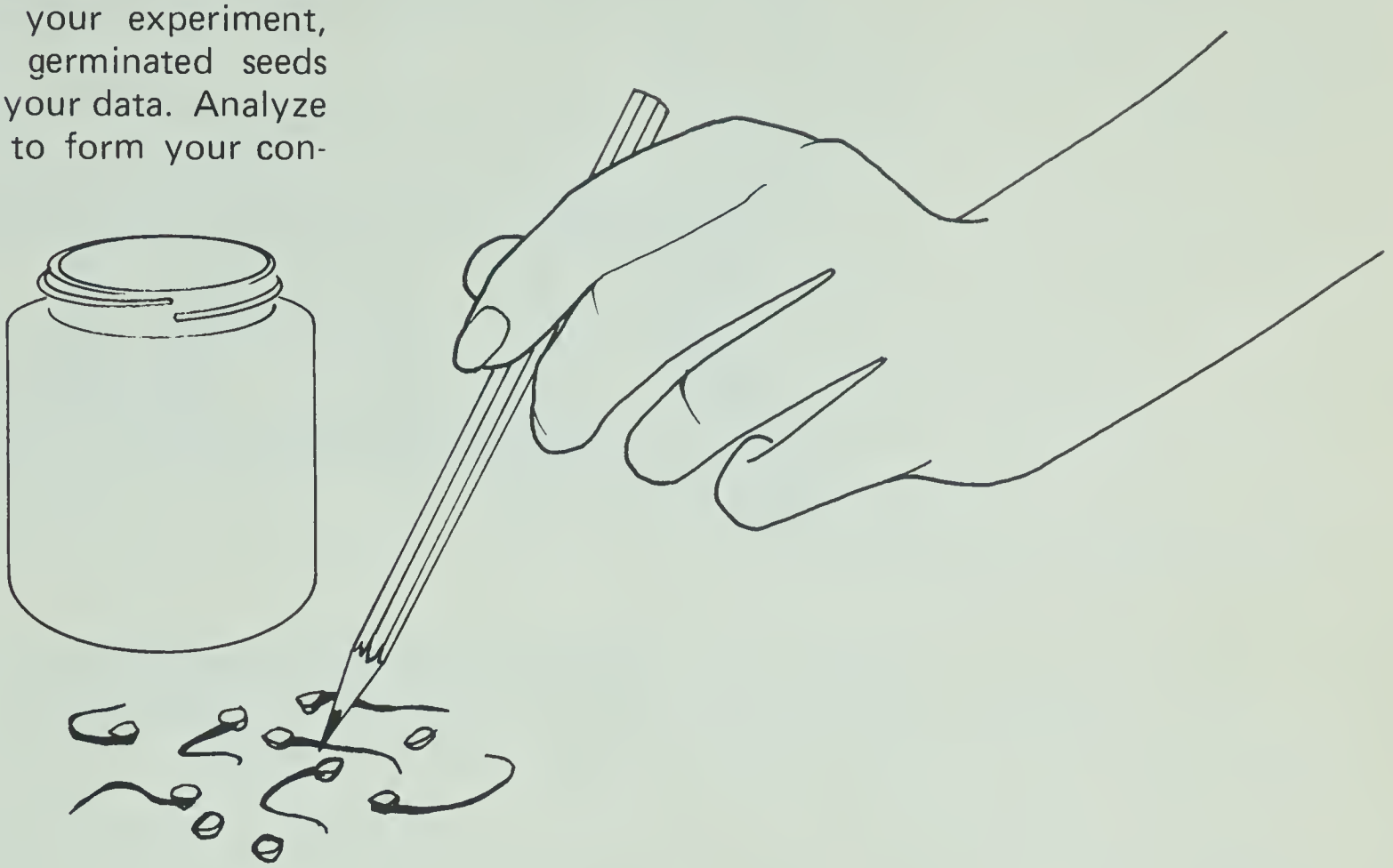
E. Put the lids on the jars. Put each jar into a shoe box. Put each covered shoe box into a dark plastic bag unless you are testing for light. If you're testing for light, leave two boxes uncovered. Put those two boxes into the clear plastic bags. Cover the third box, and put it into the dark plastic bag.

F. Put your three jars in the proper places according to the design of your experiment. The proper place may be the refrigerator, incubator, under a lamp, or on a safe shelf.

G. Do not open or disturb the plastic bags until you're ready to check your results — after the seeds germinate.

Under good environmental conditions, radish seeds will germinate in one to three days.

H. On the fourth day after you began your experiment, count the germinated seeds and record your data. Analyze the results to form your conclusions.



- 12-7. Was your hypothesis supported by the data?

- 12-8. Under which conditions of moisture, light, or temperature did the most seeds germinate?

☆ **12-9. Suppose you design an experiment to test your hypothesis — that the rate of germination of lettuce seeds in two days will be greatest in the wettest soil.**

You prepare three pots identical in size, type and amount of soil, and number of seeds (ten). You add 10 ml of water to the first pot, 30 ml to the second, and 50 ml to the third. Then you put the three pots side by side on a window sill. Which of the following is necessary to a test of your hypothesis?

A. Put two of the pots in a dark closet and one pot in the light.
B. Get a fourth pot. Put only water and seeds in it. Put it beside the other pots.
C. Get a fourth pot. Put in the same soil and ten seeds. As a control, put no water in it. Put the pot beside the others.
D. Add 1 g, 3 g, or 5 g of commercial fertilizer and the same amount of water to each of the three pots.

12-7. [Answers will vary, but it is important that the student's response is in agreement with the hypothesis and the data collected. It should be stressed that an investigation that does not support the hypothesis is as meaningful and as valid as one that does support it.]

12-8. [Answers will vary, but normally the seeds will germinate best under conditions of moderate temperature, moderate moisture, and the absence of light.]

12-9. C

ACTIVITY EMPHASIS: Plant communities respond to some kinds of changes by repopulating an area in successive stages, different types of plants being dominant at different stages.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 13: PLANT SUCCESSION

As environmental conditions in an area change, the plants that live in that area change, too. Nearby plants of all types scatter seeds, which may germinate and grow in the area. If those plants are well adapted to the changing environmental conditions, they will become established and replace the original plant populations.

In the course of time, an area may be occupied by several entirely different plant populations. This process is known as *plant succession*.

Plant successions are of various kinds, but all are made up of several stages. Each stage is characterized by different forms of plant life. In this activity, you will look at one type of succession. It is the succession from a standing freshwater community to a forest community. Figure 13-1 below shows that succession.

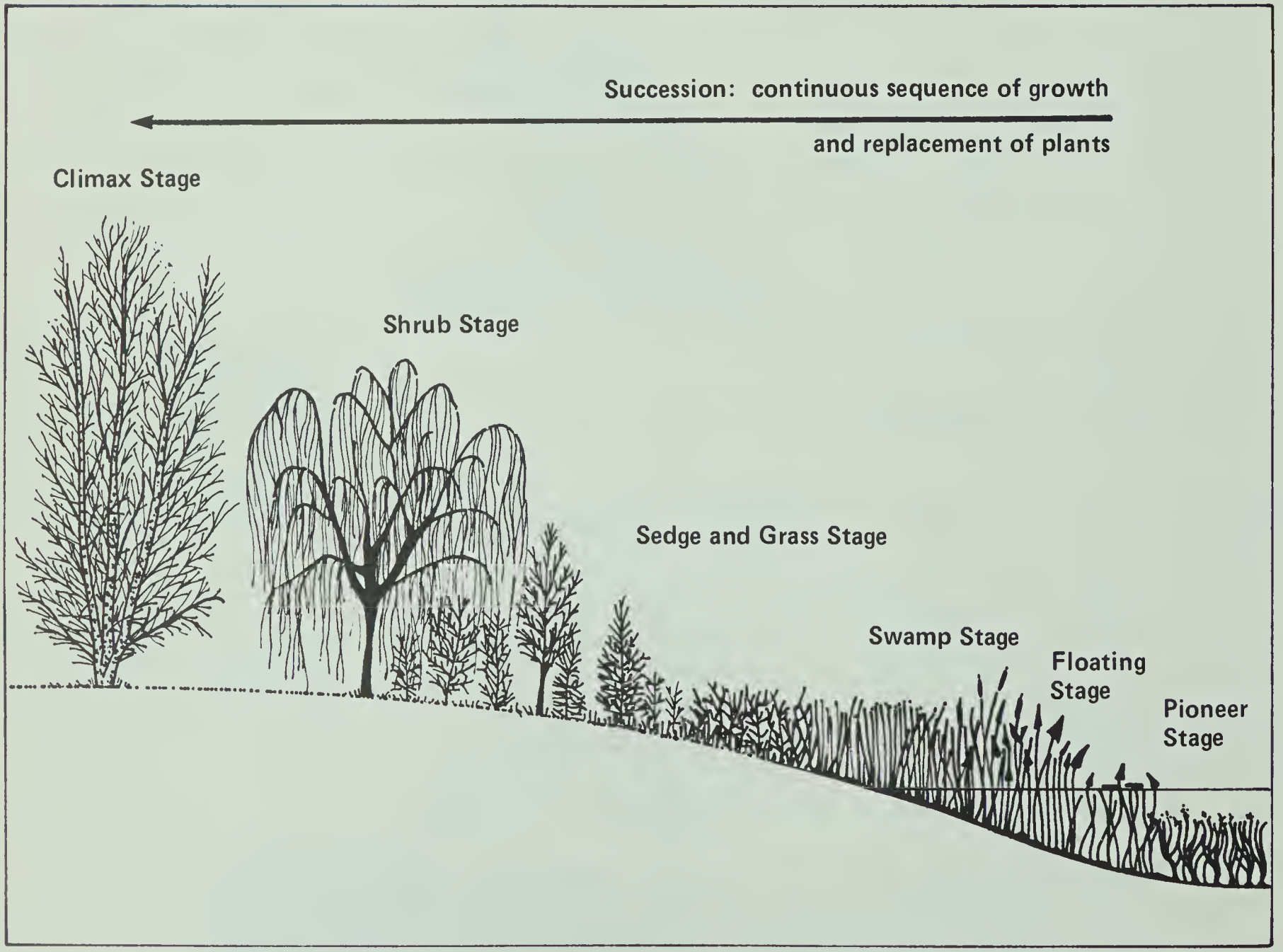


Figure 13-1

Figure 13-2 below shows the first stage — the pioneer stage — in that succession.

Figure 13-2

In the pioneer stage many submerged plants, such as eel grass and bushy naiad, colonized the bottom of the lake. They grew, reproduced, and died, generation after generation. Being well adapted to the environmental conditions, these plants increased in numbers on the bottom of the lake.

Water runoff from the shore carried silt into the lake. The silt settled. It gradually began to build up on the bottom.

Figure 13-3 below shows the next stage — the floating stage.

Figure 13-3

As the bottom built up, pond lilies and other broadleaf water weeds became rooted and grew. They increased in numbers in the shallow, muddy bottom.

The leaves of these rooted plants floated on the surface, shading the plants below them. In reduced light, the underwater pioneer plants could no longer survive. Decay and runoff also occurred, so the lake began filling in and became smaller and smaller.

13-1. Pioneer plants are underwater, whereas floating plants are rooted below water and their leaves float on the water's surface.

● 13-1. What is the main difference between the plants of the pioneer stage and the plants of the floating stage?

Figure 13-4 below shows the third stage in the succession — the swamp stage.

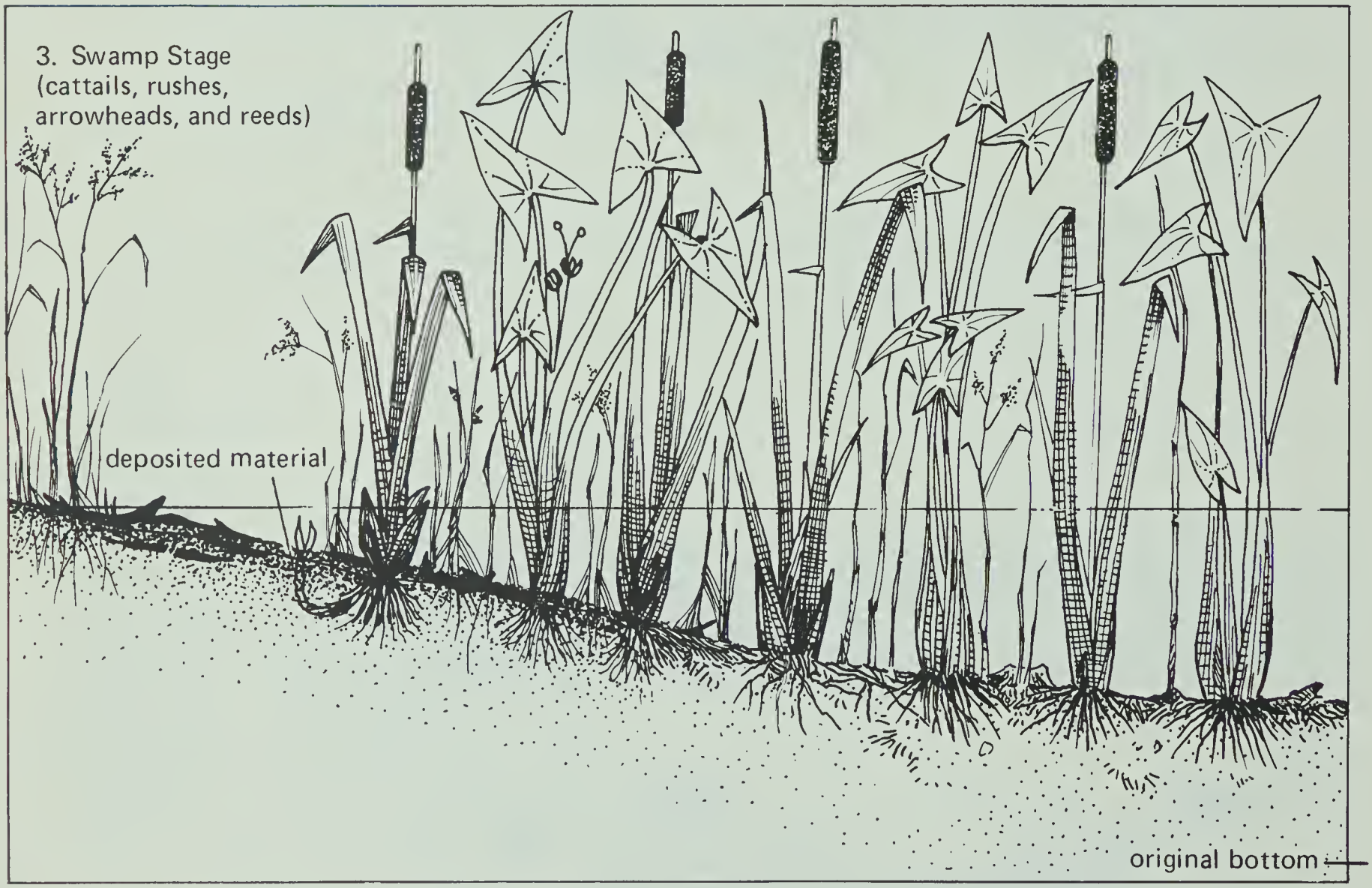


Figure 13-4

With the decreasing depth of water, cattails, rushes, and arrowheads invaded this area. The tops of these plants grew above the surface of the water, shading the plants below them. Decay, silting, and runoff continued, and the lake became even smaller.

13-2. Plants that grow above water, such as cattails, rushes, and arrowheads

● 13-2. What kinds of plants are found in the swamp stage?

Figure 13-5 below shows the fourth stage – the sedge and grass stage.

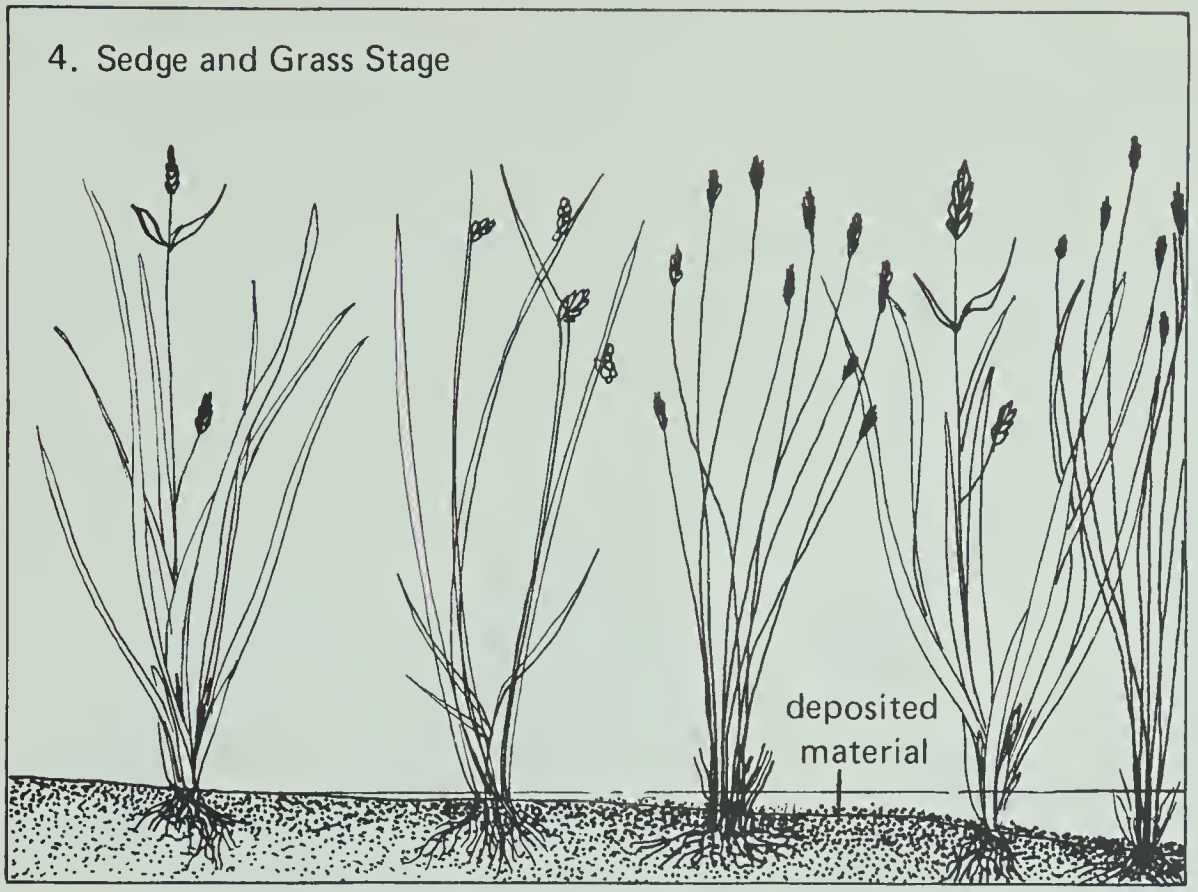


Figure 13-5

Eventually, the soil became dry enough to provide a suitable surface for land plants, such as sedges and grasses.

Figure 13-6 below shows the fifth stage – the shrub stage.

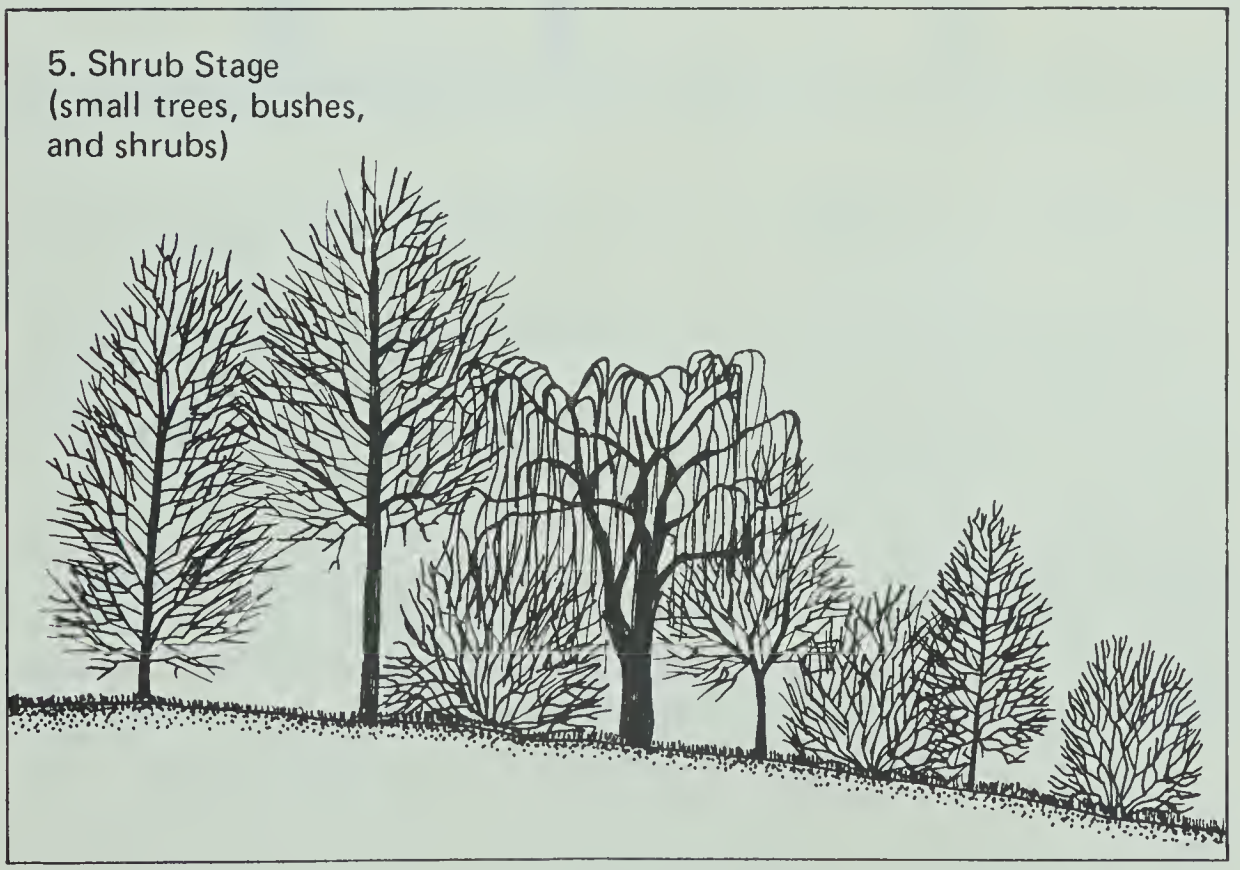


Figure 13-6

Sedge and grasses were then replaced by shrubs and small trees. These are usually an excellent protective cover for animals that come to the lake to drink.

13-3. The soil is damper at the sedge and grass stage, and plants are mostly grasses. In the shrub stage, the plants are shrubs and small trees in drier soil.

● 13-3. What are the differences between the sedge and grass stage and the shrub stage?

Figure 13-7 below shows the final stage in the succession — the climax stage.

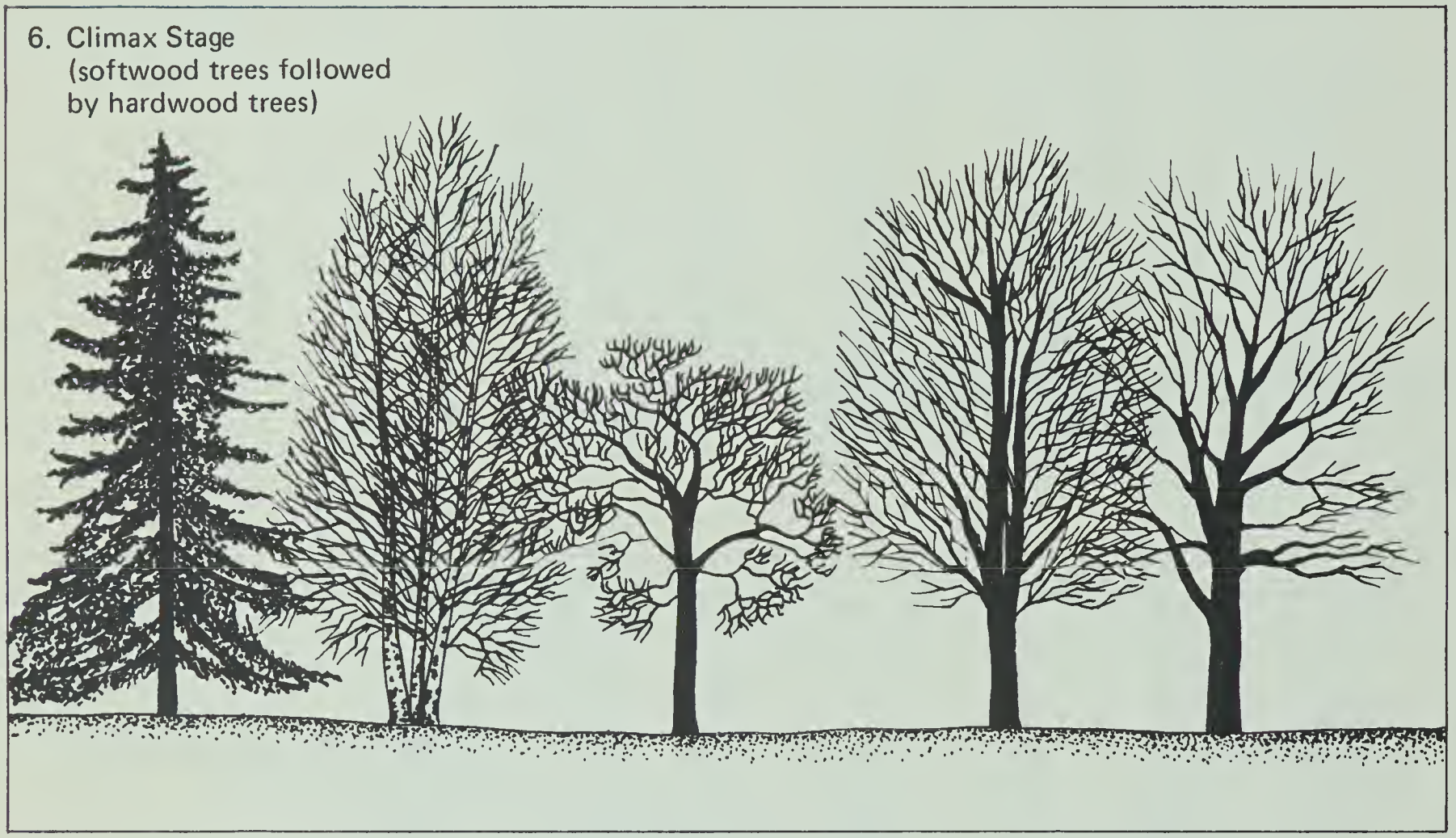


Figure 13-7

Tall trees are the dominant members of the climax stage of succession. The first trees to appear may not be the same species as the final climax members. Early ones, such as willows, are adapted to moist conditions.

As the lake continues to shrink, the type of trees in the area will probably change. Those that require less water for survival will eventually dominate. The species of trees that dominate the area surrounding the lake will cover the former lake area, too, in the final climax stage.

Plant populations continally reproduce, replacing those that die. The climax community continues to have the same combination of species unless environmental conditions change or people interfere by building or cutting.

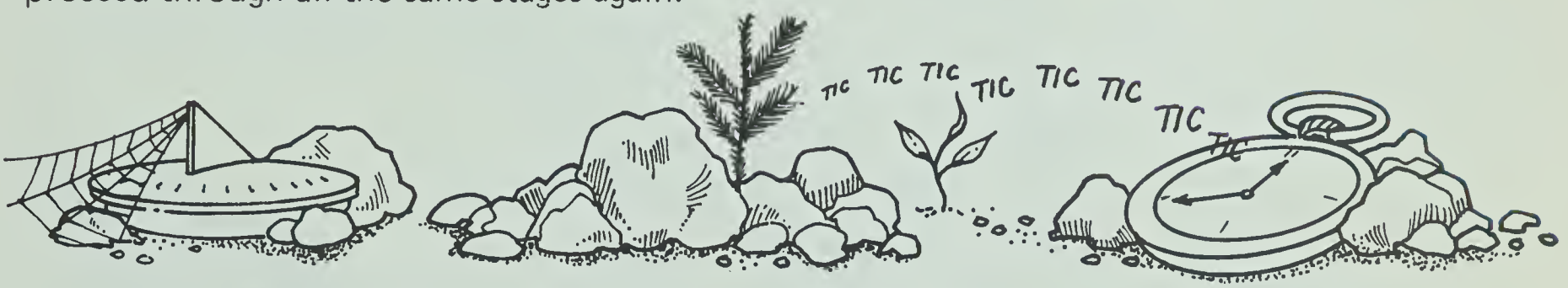
● 13-4. The original bottom of the standing freshwater community shown in Figure 13-1 (page 54) got filled with soil. What caused this?

13-4. The decay of plants in the lake, as well as deposited materials from land runoff

● 13-5. Name the stages during which the lake became shallower and shallower before finally filling in.

13-5. The floating, sedge and grass, swamp, and shrub stages

A forest does not suddenly take possession of a patch of soil. This process of succession may require hundreds or even thousands of years. The time required depends upon several factors, especially climatic conditions and soil and rock types. Catastrophes, such as fires, flooding, or lumbering, may destroy vegetation. Then succession is disrupted and must begin again and proceed through all the same stages again.



Various types of plants may be involved in different types of succession. As plants grow, they change the environment in many ways, perhaps making it more suitable for other plants. Those plants then appear when their seeds are carried or blown into this environment. As plant types change, the animal types change too.

☆ **13-6. Match each of the following plants to its stage of succession.**

13-6. A2, B4, C3, D6, E1, F5

Plant	Stage
A. Pond lilies and broadleaf weeds	1. pioneer
B. Grasses	2. floating
C. Cattails, rushes, and arrowheads	3. swamp
D. Tall trees	4. sedge and grass
E. Eel grass and bushy naiad	5. shrub
F. Bushes, small trees, and shrubs	6. climax

Some changes, or stages of succession, are predictable and well defined. The evolution of the standing freshwater community to the forest community is a good example. Other changes, such as those involving the marine and desert communities, are usually not so clearly patterned.

● 13-7. What name is given to the series of changes in plant communities resulting from environmental changes?

13-7. Plant succession

ACTIVITY EMPHASIS: A food pyramid illustrates the loss of energy that occurs as energy is transferred through a biological community.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 14: FOOD PYRAMIDS

Food is the main source of energy for animals in an environment. The sun is the original source of this energy. A small part of the sun's energy is used by plants and transferred to other organisms, as shown in Figure 14-1 below.

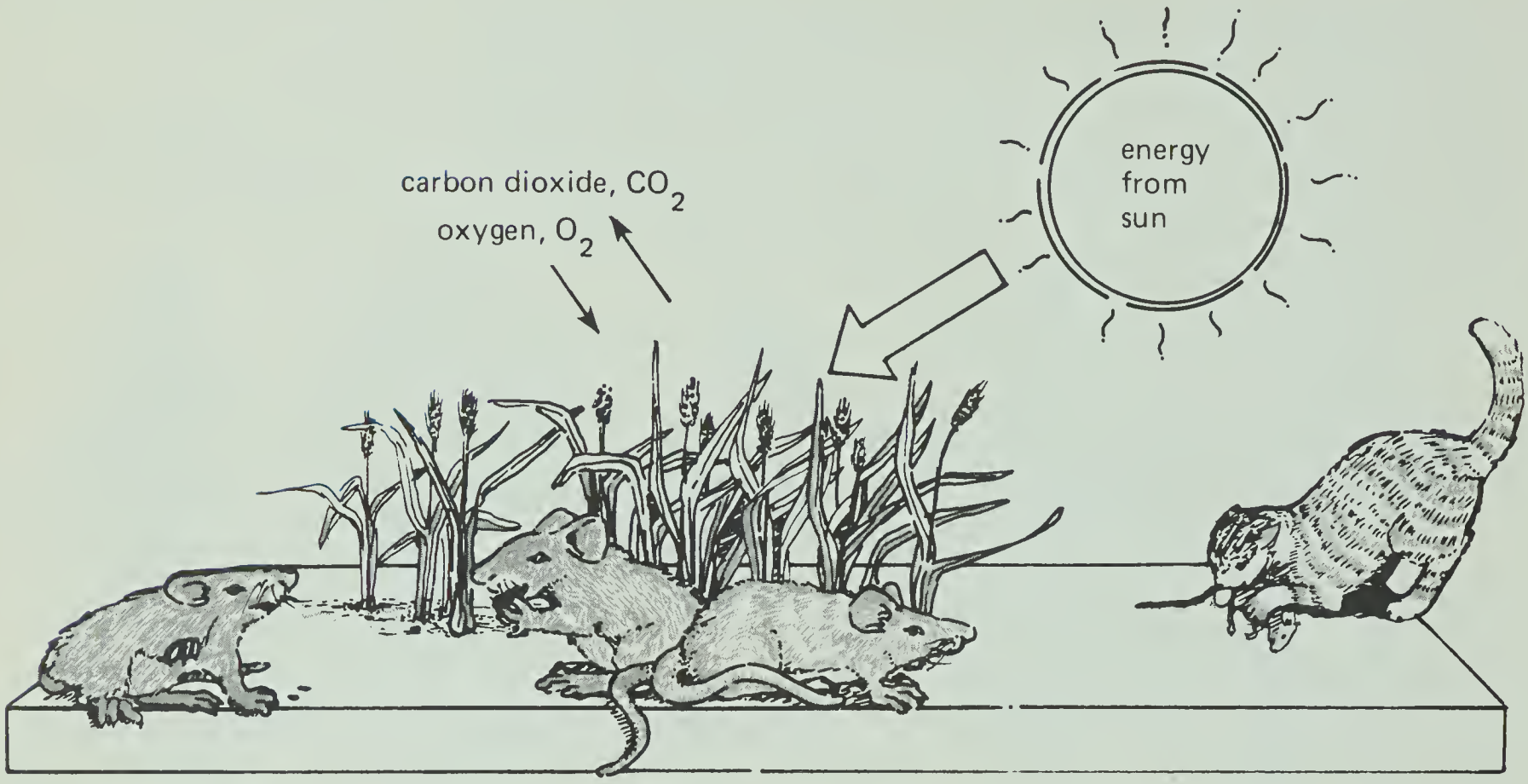


Figure 14-1

As you can see, green plants make food by using the sun's energy. Animals eat the plants or other animals to get energy.

There are various types of energy transfer between and among organisms in a local community. The relationships involved are called *food chains* and *food webs*, as you learned in Activity 5.

14-1. Plant plankton → aquatic insect → frog → snake → eagle

● 14-1. Diagram a food chain for the following: eagle, aquatic insect, snake, frog, and plant plankton.

Food chains and food webs show energy transfer. But they do not show the number of each type of organism or the amount of energy transferred. The purpose of this activity is to study energy transfer in somewhat more detail.

To indicate energy transfer more accurately, scientists diagram food chains in the form of pyramids. Figure 14-2 (page 61) shows a pyramid for the food chain of Question 14-1 and lists the characteristics of food pyramids.

Characteristics of Food Pyramids

1. There are many organisms at the bottom and few at the top.
2. Small organisms are at the bottom, and large ones are at the top.
3. Producers are at the bottom, and consumers are at the top.
4. There is much stored energy at the bottom, but little at the top.
5. Life cycles are normally shorter for smaller organisms and longer for larger organisms.

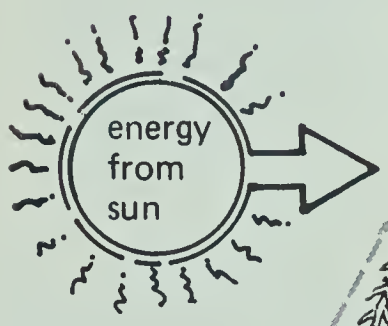


Figure 14-2

Each organism gets energy from its food — the organism directly below it in the food pyramid. Some of this energy is used in the organism's life processes. Unused energy is stored in the organism's body as carbohydrates (sugars and starches), proteins, or fats.

Look at Figure 14-3 below. The first level of the food pyramid consists of plant plankton — floating, green, microscopic-sized plants found in water. They produce their own food through photosynthesis.

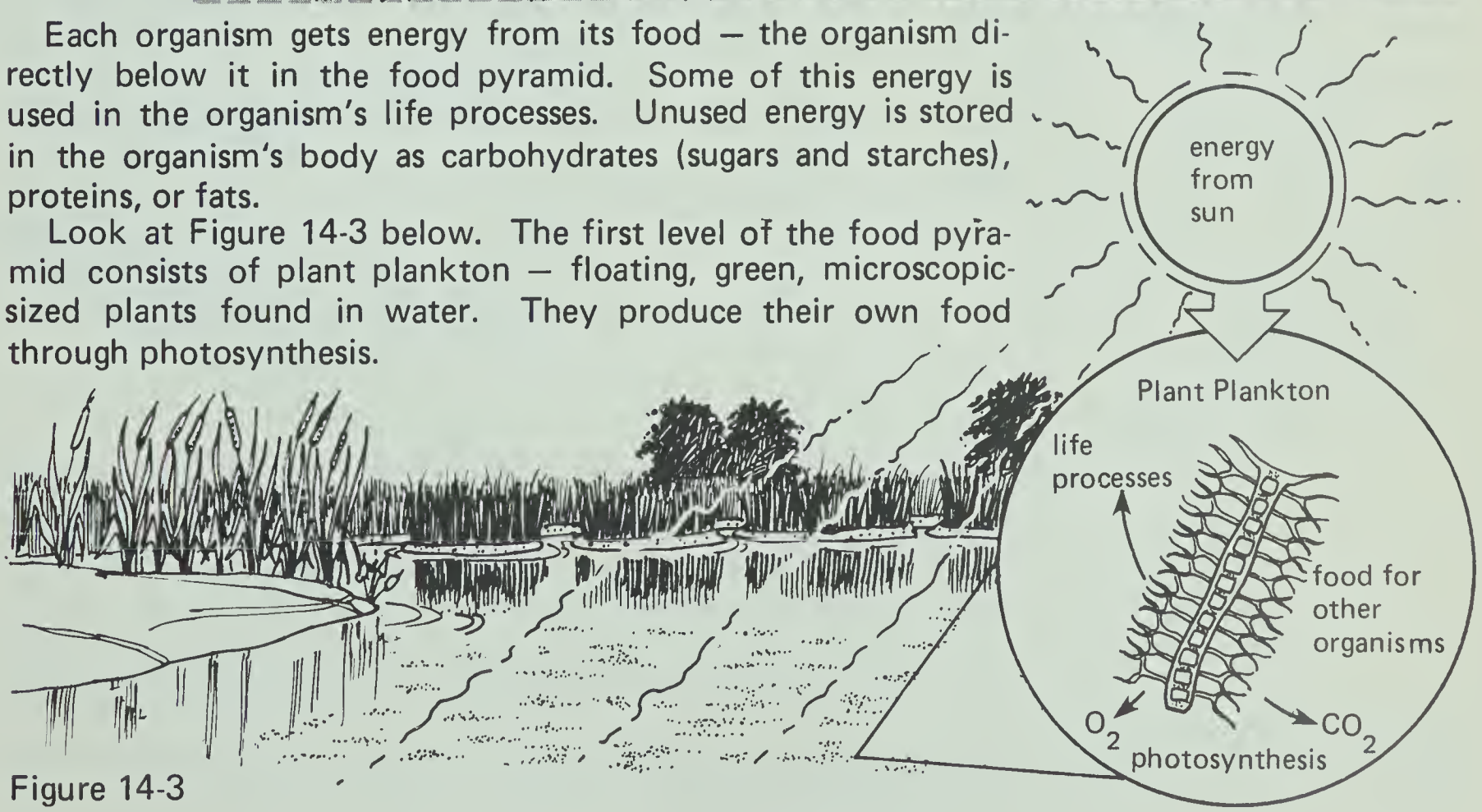


Figure 14-3

14-2. The sun

- 14-2. What is the source of energy for the plant plankton?

There is more stored energy at the first level of the pyramid than at any other. The reason for that is the almost endless supply of energy from the sun, which allows many plankton to grow and reproduce rapidly.

Aquatic insects swim in the water and constantly feed on the floating plant plankton. Figure 14-4 below shows that second level of the pyramid.

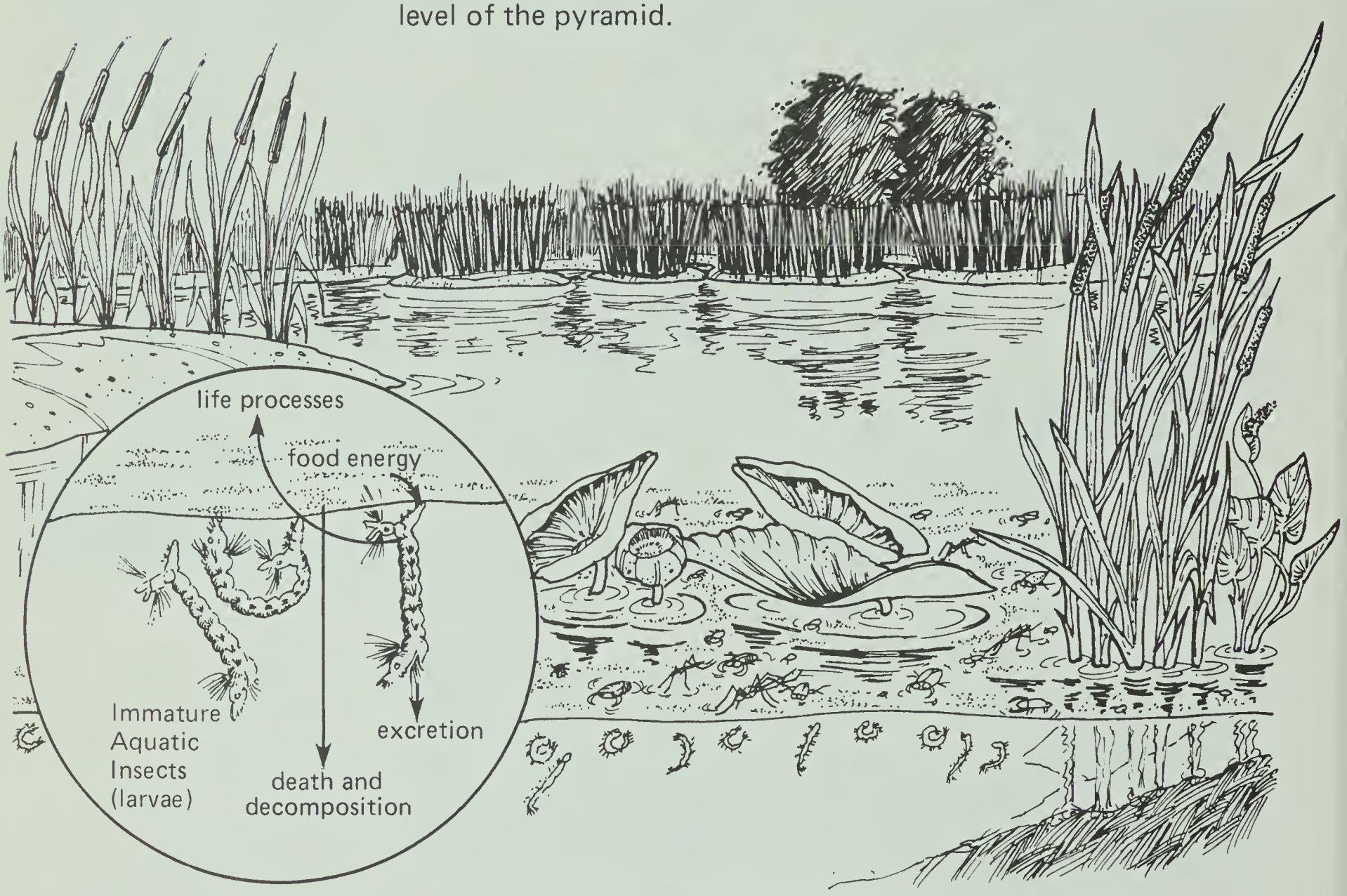


Figure 14-4

Not all of the stored energy at one level is passed to the organisms at the next level. For example, some plankton are not eaten. They die and are decomposed by bacteria. And those that are eaten cannot be completely digested by the insects. The unused portion is excreted, and it too decomposes. In addition, the life processes of the organisms involved use some energy.

14-3. Life processes, incomplete digestion, and death and decomposition

☆ **14-3. What are three ways that energy is lost from the food pyramid at each level?**

Frogs live both in and out of the water. Aquatic insects are their main source of food. Look at Figure 14-5 below. It shows the third level of the pyramid.

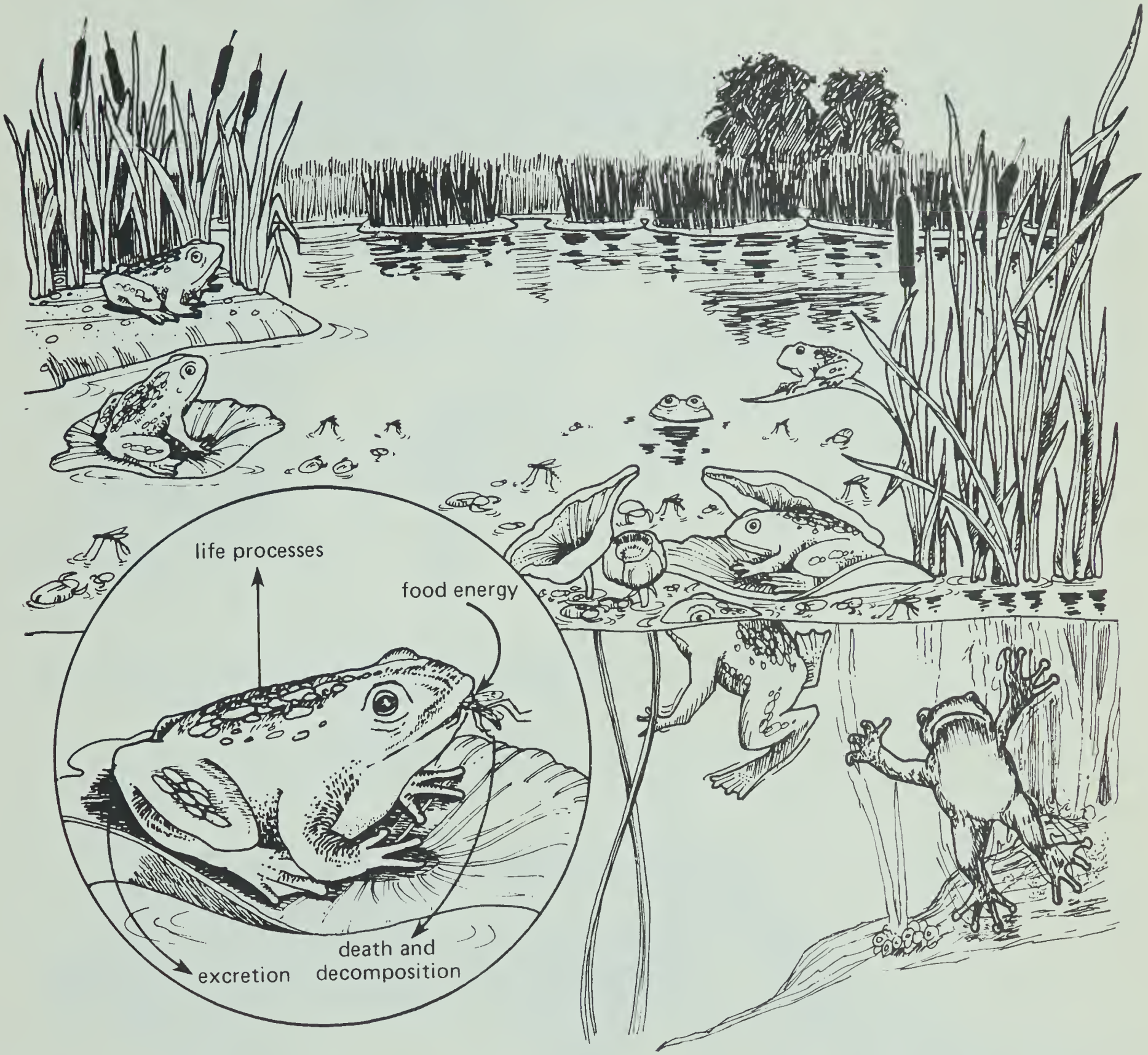


Figure 14-5

• 14-4. Is all of the stored energy of the aquatic insects transferred to the frog population? Explain your answer.

14-4. No, some energy is utilized in the life processes. Some is lost through death or incomplete digestion.

Snakes, which are found at the fourth level of this food pyramid, often feed on frogs. Look at Figure 14-6 below.

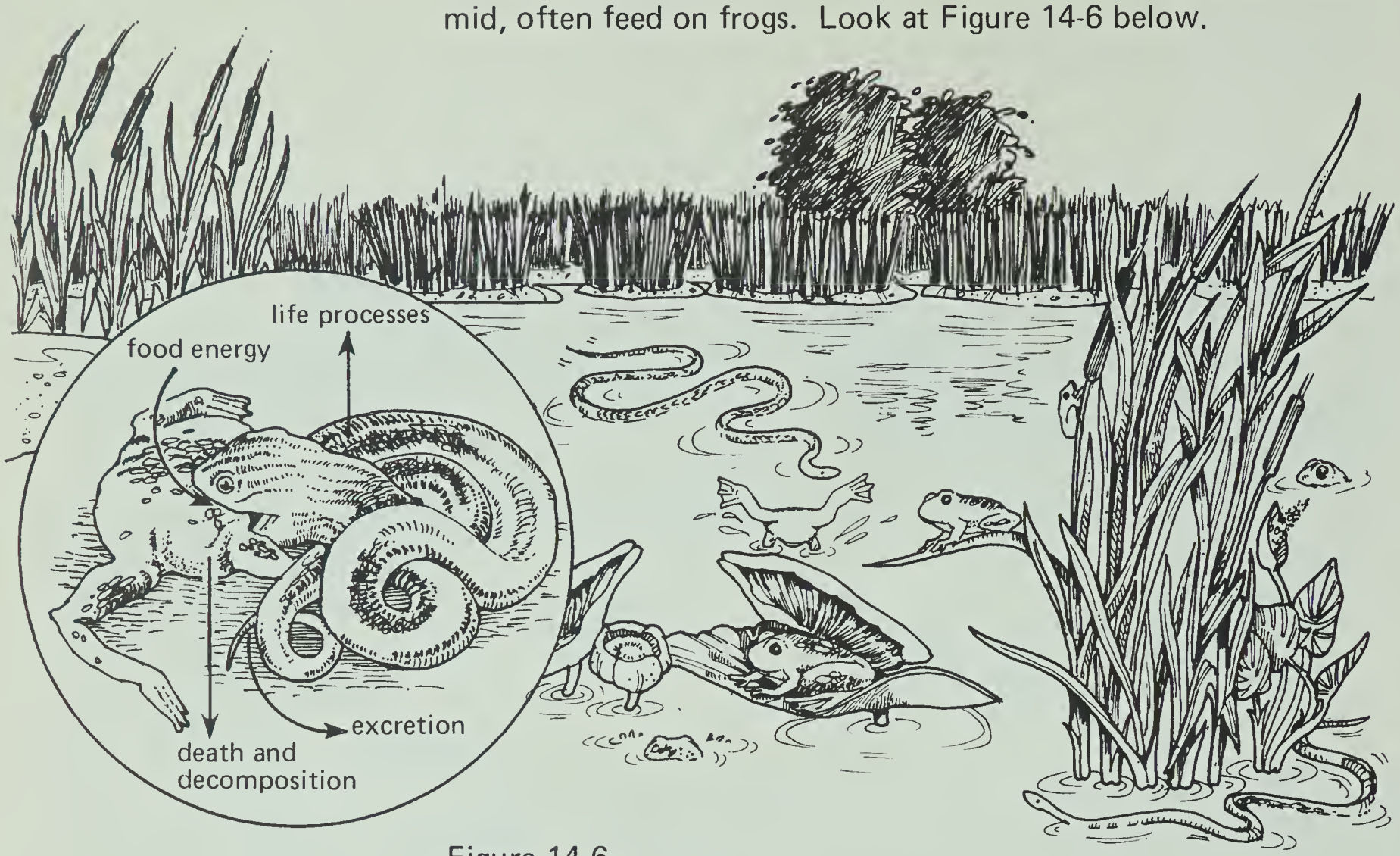


Figure 14-6

14-5. Frogs; aquatic insects

☆ **14-5. Which population has more stored energy available in its food source — frogs or snakes? Aquatic insects or frogs?**

In a community such as the one shown in this food pyramid, there is usually just one eagle. Look at Figure 14-7 below.

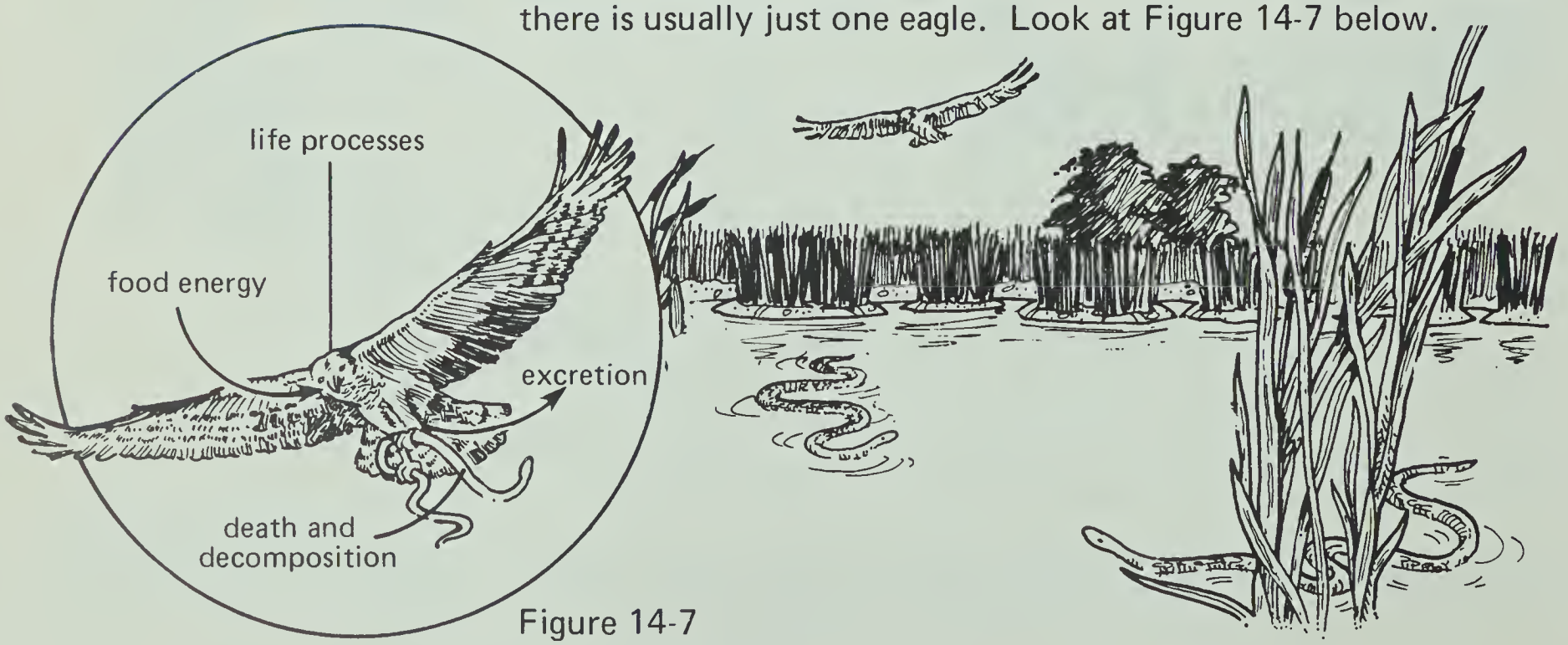


Figure 14-7

● 14-6. Why are there usually more snakes in a community than there are eagles?

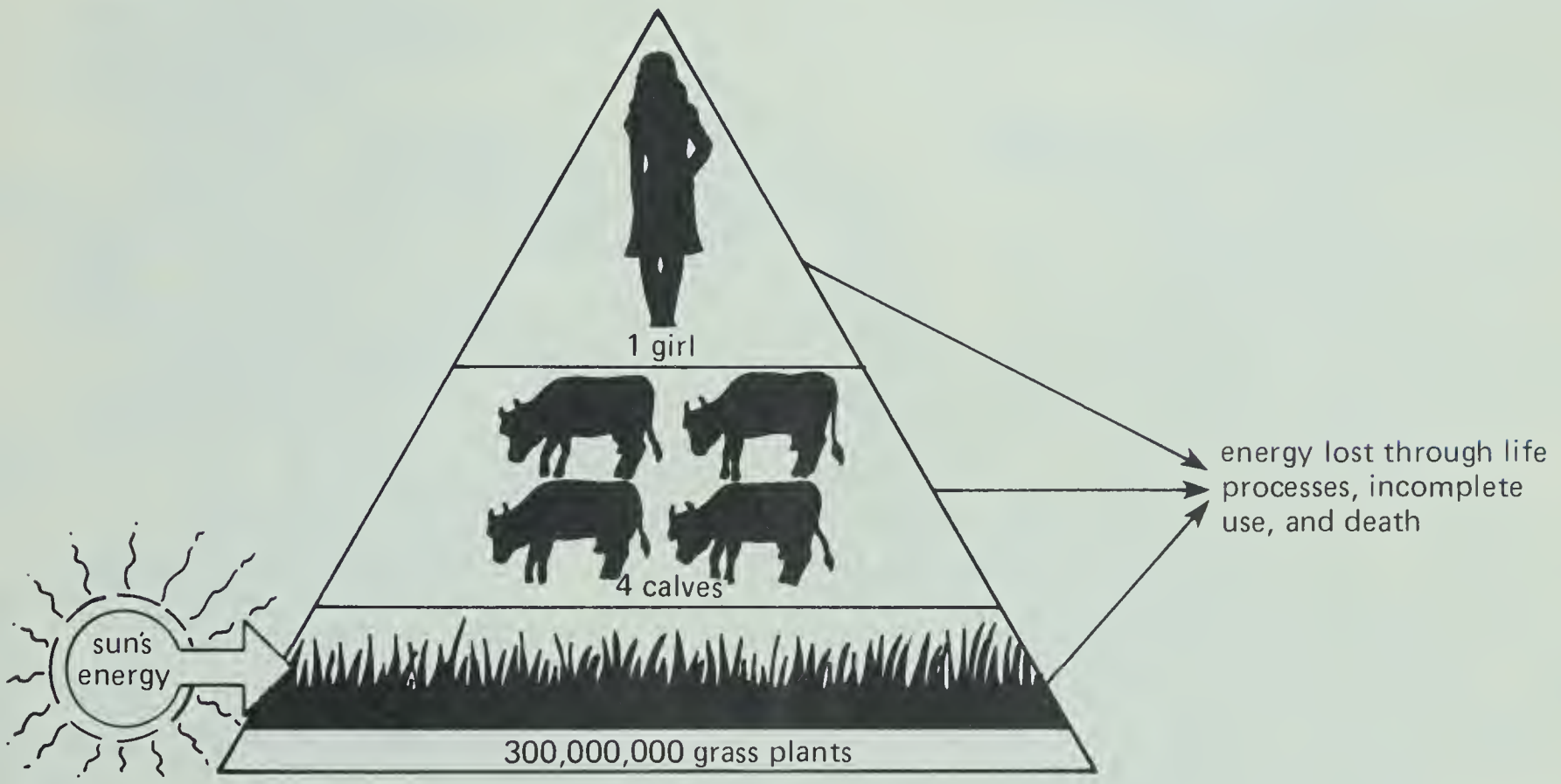
14-6. There is more stored energy available in the snake's food source than in the eagle's.

Less and less energy is passed upward through the food pyramid. At each level, organisms use some of the available stored energy for their own life processes. And some energy is lost when organisms are not eaten or when they are eaten but only partly digested. At every level, dead organisms or partially digested ones are consumed by decomposers, which use the stored energy for their own life processes.

Every organism needs energy to live. So, all other things being equal, the higher a population's level on the pyramid, the fewer members the population will have. As the saying goes, "It's lonely at the top."

☆ **14-7. In what ways is energy lost from the pyramid at any level?**

14-7. By life processes, incomplete use, and death and decomposition



● 14-8. What is the original source of energy for all of the members of a food pyramid?

14-8. The sun

☆ **14-9. Which level of a food pyramid makes available the least amount of stored food energy?**

14-9. The top level

● 14-10. At which level of a food pyramid are producers normally found? Why? Where are consumers found? Decomposers?

14-10. At the first level, because they convert the sun's energy into usable energy; at all levels but the first; at all levels but the first

Excursion

ACTIVITY 15: PLANNING

Activity 16 Page 67

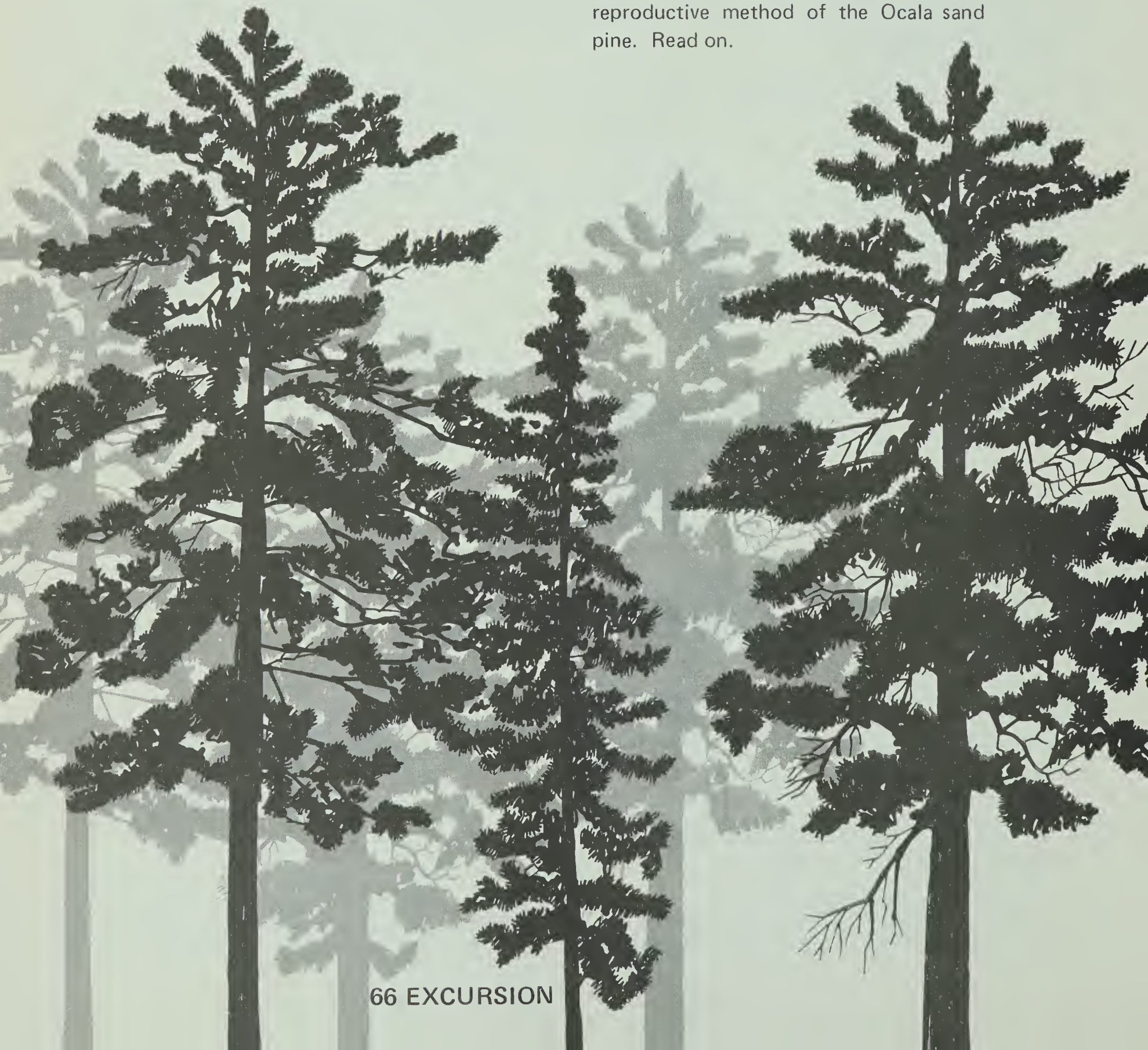
Don't Crowd Them

All living things are in competition. They compete for food, space, light, air, and water. In this activity, you'll raise some plants, watch them compete, and see how the competition affects them.

Activity 17 Page 72

The Pine Tree Mystery

Do you like a good mystery? Try this one. It involves a mysterious stand of pine trees, all about the same size. But no one planted them. Is this a tree farm from outer space? The key is in the reproductive method of the Ocala sand pine. Read on.



ACTIVITY 16: DON'T CROWD THEM

ACTIVITY EMPHASIS: When plants are spaced too closely, they compete for environmental resources. Competition is most severe for the scarcest resources.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

This activity should be started early in the minicourse, as it will take up to two weeks to complete.

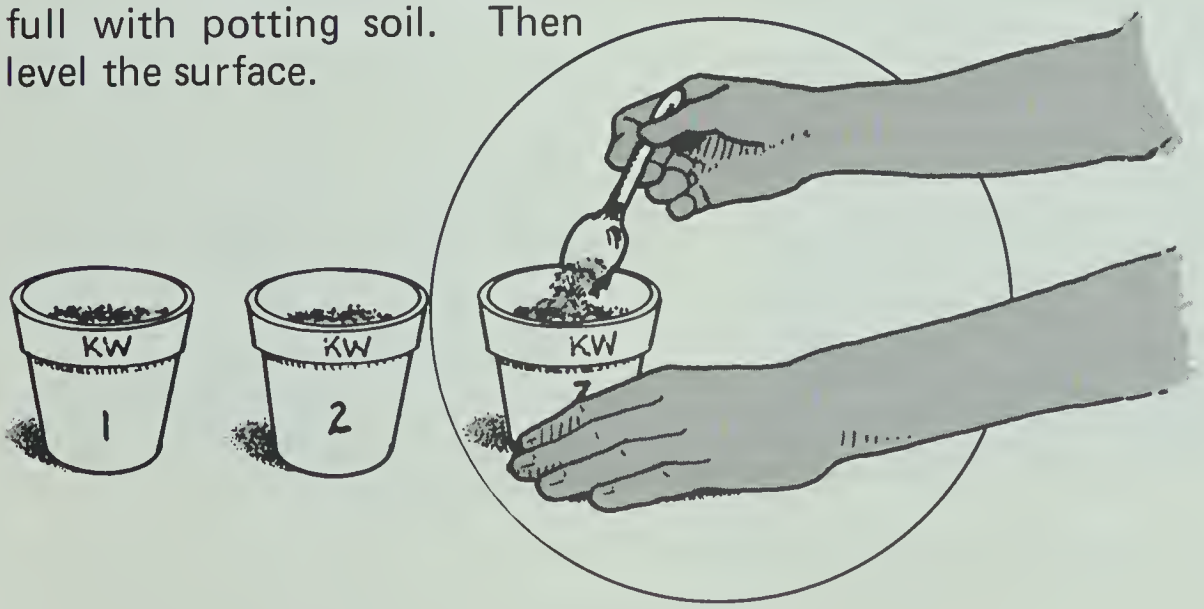
Green plants are always competing with one another. They compete for light and for water. They compete for the carbon dioxide needed in photosynthesis. They compete for living space and for the minerals necessary for growth. Sometimes, though, plants can't get all these things. When that happens, plant development is affected.

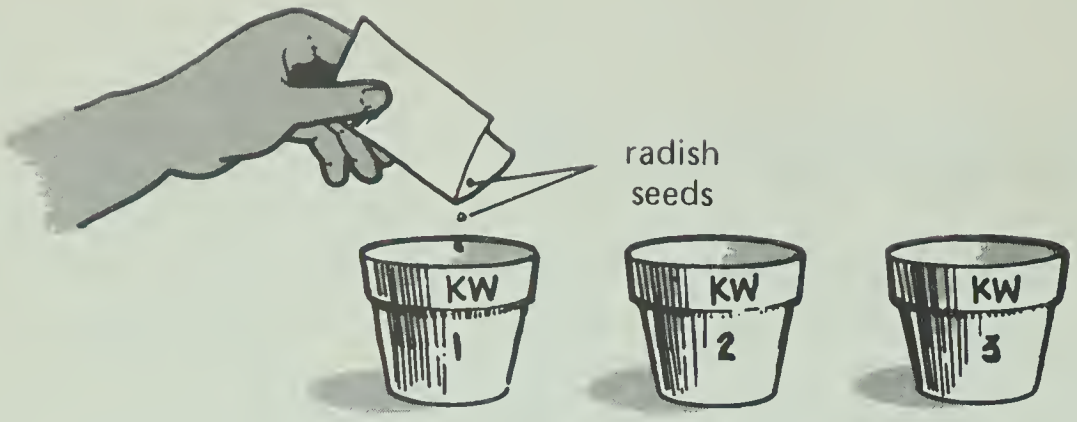
In the following investigation, you can see how crowding affects plant growth. Start the investigation right away, and work through Steps A through F now. You need to give the plants time for growing while you are working on other activities. In all, you'll need from eight to fourteen days and the following materials.

3 small flower pots or plastic cups
potting soil
100 radish seeds
milk carton cut in half lengthwise (or tray)
grease pencil
metric ruler
150-watt lamp or direct sunlight

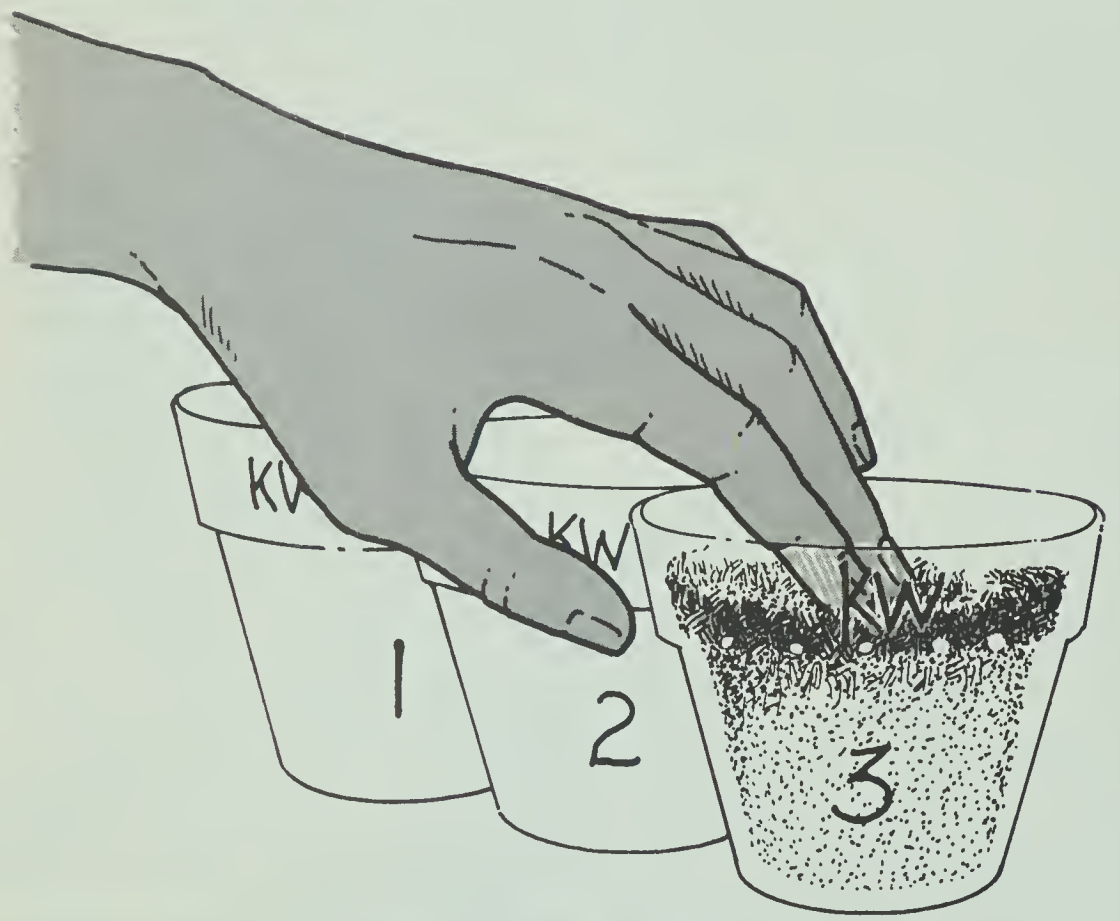
A. Using the grease pencil, label the three pots *1, 2,* and *3* and put your initials on them. If plastic cups are used, poke a hole in the bottom of each.

B. Fill each pot three-quarters full with potting soil. Then level the surface.

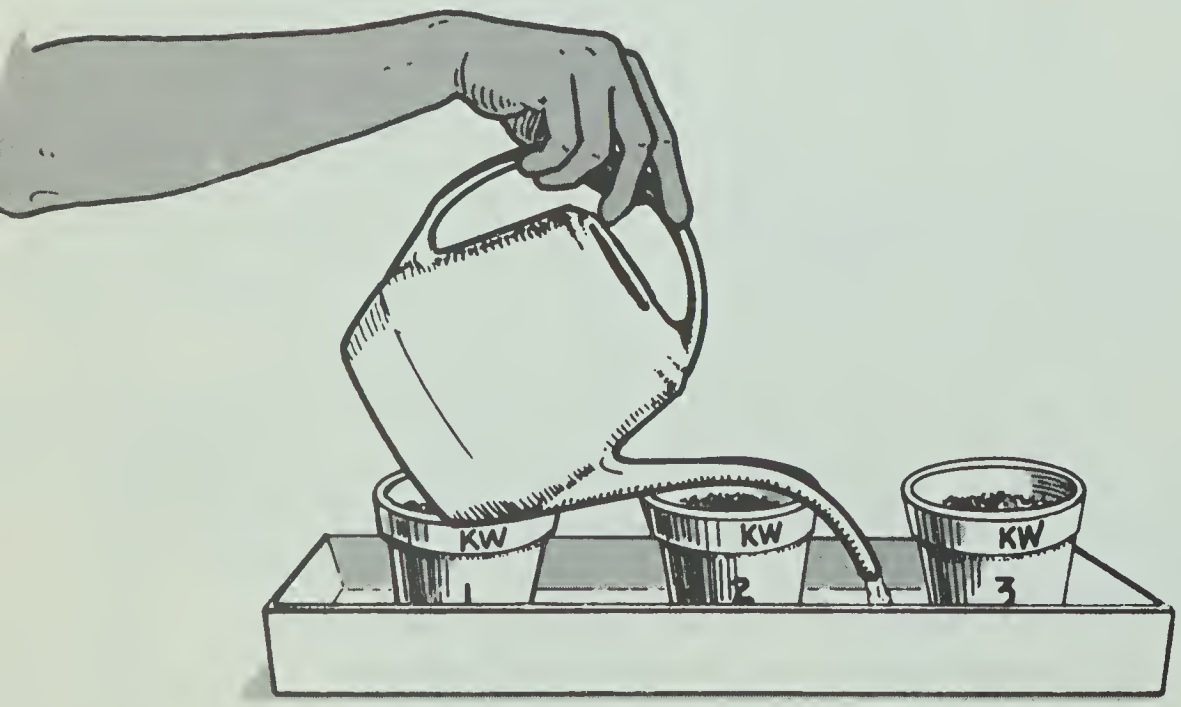




C. Count out 5 radish seeds for Pot 1, 15 for Pot 2, and 80 for Pot 3. Sprinkle the seeds evenly on top of the soil in the pots.



D. Cover the seeds with about 1 cm of new soil. Then level the surfaces again, very gently.



E. Put the three pots into the tray. Pour water into the tray (not into the pots!) to a depth of about 0.5 cm. Put the tray near the window in direct sunlight, or put it under the lamp.

F. In your notebook, draw a table similar to this one. Your table should go through Day 14. You may not need to measure your plants for the whole 14 days if they have grown fast enough. Check with your teacher.

DAY	POT 1 (5 seeds)		POT 2 (15 seeds)		POT 3 (80 seeds)	
	Number of Plants	Average Height	Number of Plants	Average Height	Number of Plants	Average Height
1	0	0	0	0	0	0
2						
3						
4						

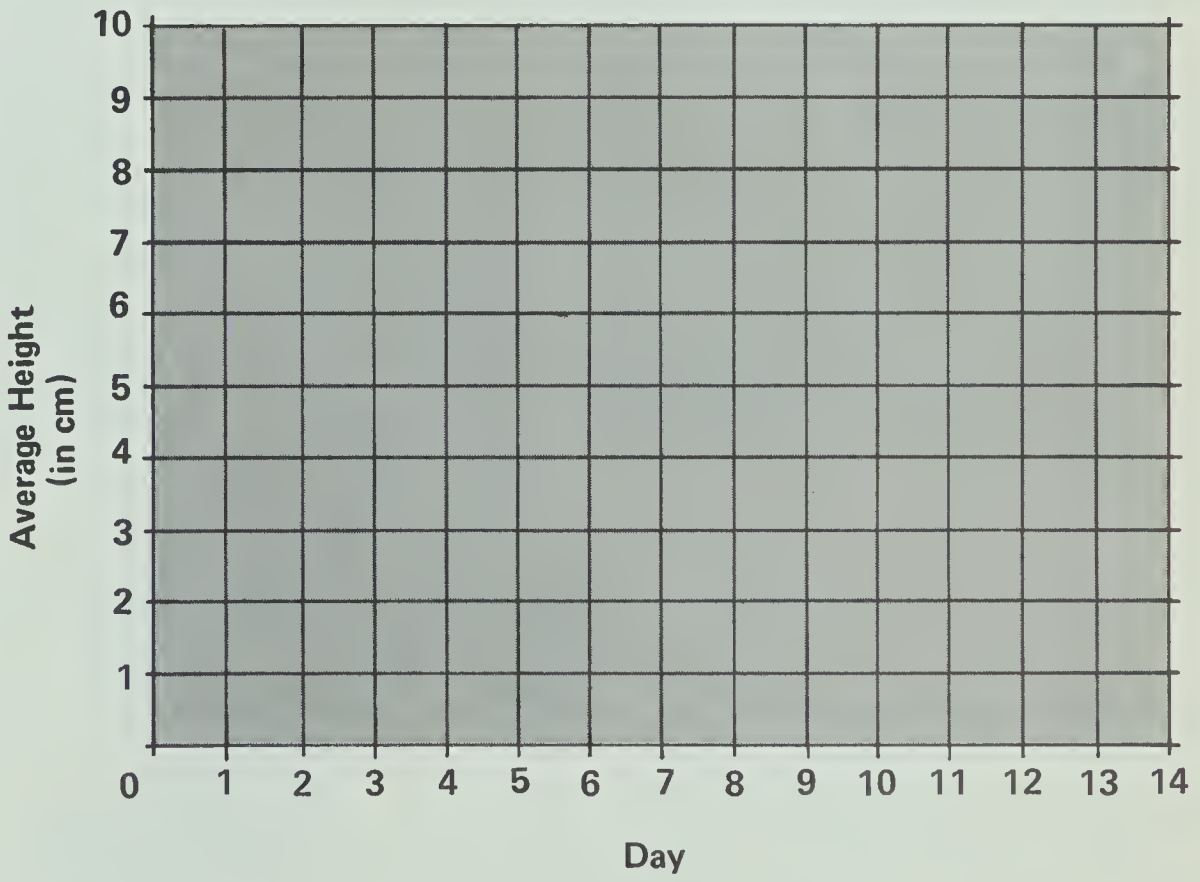
Over the next eight to fourteen days, you'll be using your table to keep a daily record about the radish seeds. Each day, you should count and record the number of plants visible in each pot. Of course, this number will be *0* for the first few days.

When plants appear, you need to determine their average height each day in each pot. To do this, measure every plant in Pot 1, at least five plants in Pot 2, and at least ten plants in Pot 3. Record these averages daily. If you're not sure how to calculate an average, read "Resource Unit 1: Averaging."

Be sure to add water to the tray every day. Don't let the tray bottom get dry.

In eight to fourteen days, your plants will be ready for use in the rest of this activity. Meantime, work on other activities. But don't forget to check your seeds every day and record your data.

G. When your plants are tall enough, you're ready to draw some conclusions about your radish seeds. You'll need to use the information from your table in your notebook. First make three grids similar to the one shown here. Then complete three graphs, one for the data on each pot. If you need help, read "Resource Unit 4: Making Graphs." Finally, use your data to answer the questions on page 70.



16-1. [Answers will vary, but about the third day is typical.]

16-2. [Answers will vary, but by the fifth or sixth day some differences in height should be noticeable.]

16-3. No, more plants have died in Pot 3 than in the other two. And the average height there is less.

16-4. Probably in Pot 1

16-5. Space to grow

16-6. The plants in Pot 1 would because there are fewer of them to share the same amount of water.

- 16-1. On which day did plants first become visible?

- 16-2. On which day did you first notice a difference in the height of the plants in the three pots?

- 16-3. Are all the plants in the three pots growing equally well? If not, in which pot have plants grown the least?

- 16-4. In which pot have plants grown the most?

You probably found that the pot with the most plants — Pot 3 — had the smallest plants. The seeds in Pots 1 and 2 probably grew rather well.

- 16-5. These results show the effects of competition. What do you think the plants are competing for in the moist soil?

- 16-6. Competition is usually strongest for the scarcest resource. Suppose you set up a second group of pots under the same conditions as before. But suppose that this time you forgot to water the plants from the fourth day on. All the plants would die after a while. But which would probably last longest? Why?

H. Carefully remove the plants from each pot by turning over the pot and tapping the bottom. Crumble away the soil gently with your fingers. Be careful not to damage the small roots. Look at the amount of root development on several plants from each pot.

Students may find that root growth, leaf size, and percentage of germination are better indicators than height.

• 16-7. Is there any difference in root development among the different pots? If so, describe what you found.

16-7. [Answers will vary, but a definite difference in the size and shape of the roots should be noticeable.]

☆ **16-8. Suppose you have three small pots containing mature radish plants. Pot A contains 3 plants. Pot B contains 20 plants. And Pot C contains 50 plants. From which pot would you probably get the largest radishes? Explain your answer.**

16-8. Probably from Pot A because there would be much less competition and the roots would be able to develop much better

Plant competition gets fiercer than you might think. Many plants produce chemicals that can kill or stunt neighboring plants! Where this sort of "chemical warfare" is going on, plants may be spaced wide apart as in Figure 16-1 below. Other plants, lacking the chemicals, grow closer together as in Figure 16-2 below.

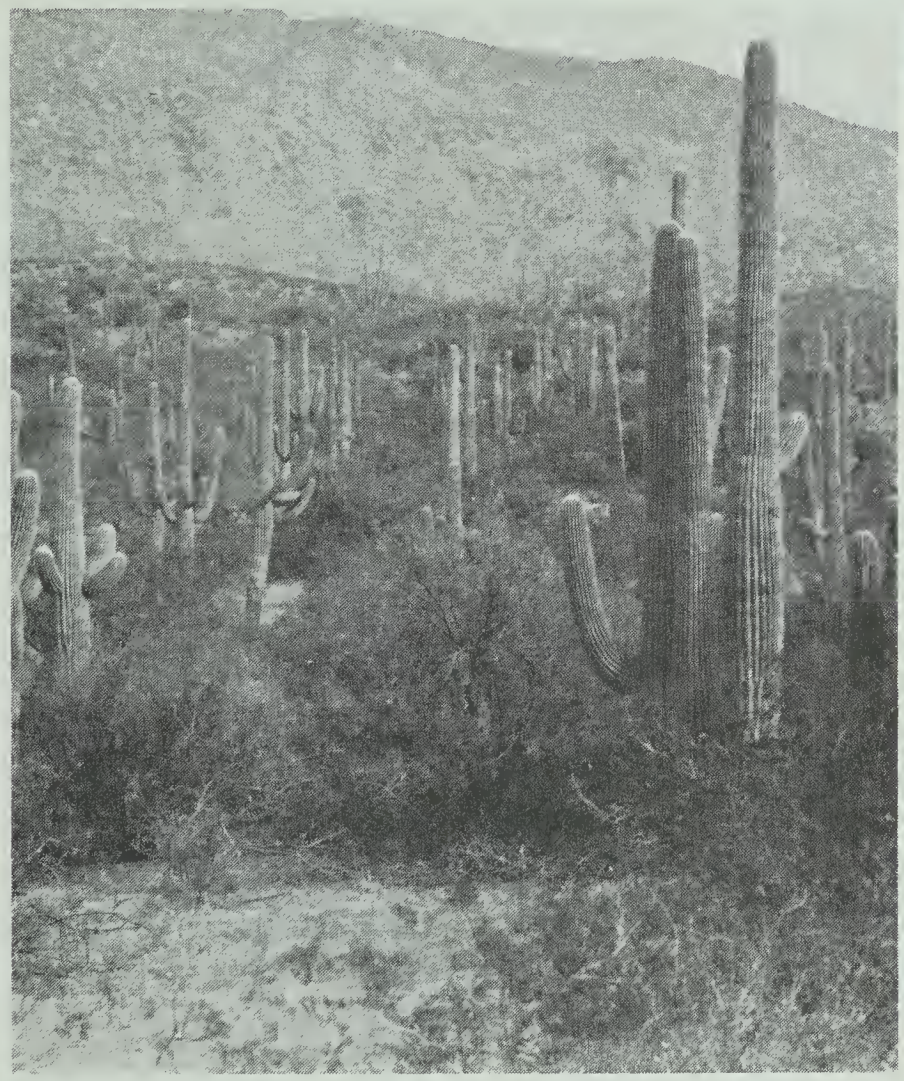


Figure 16-1

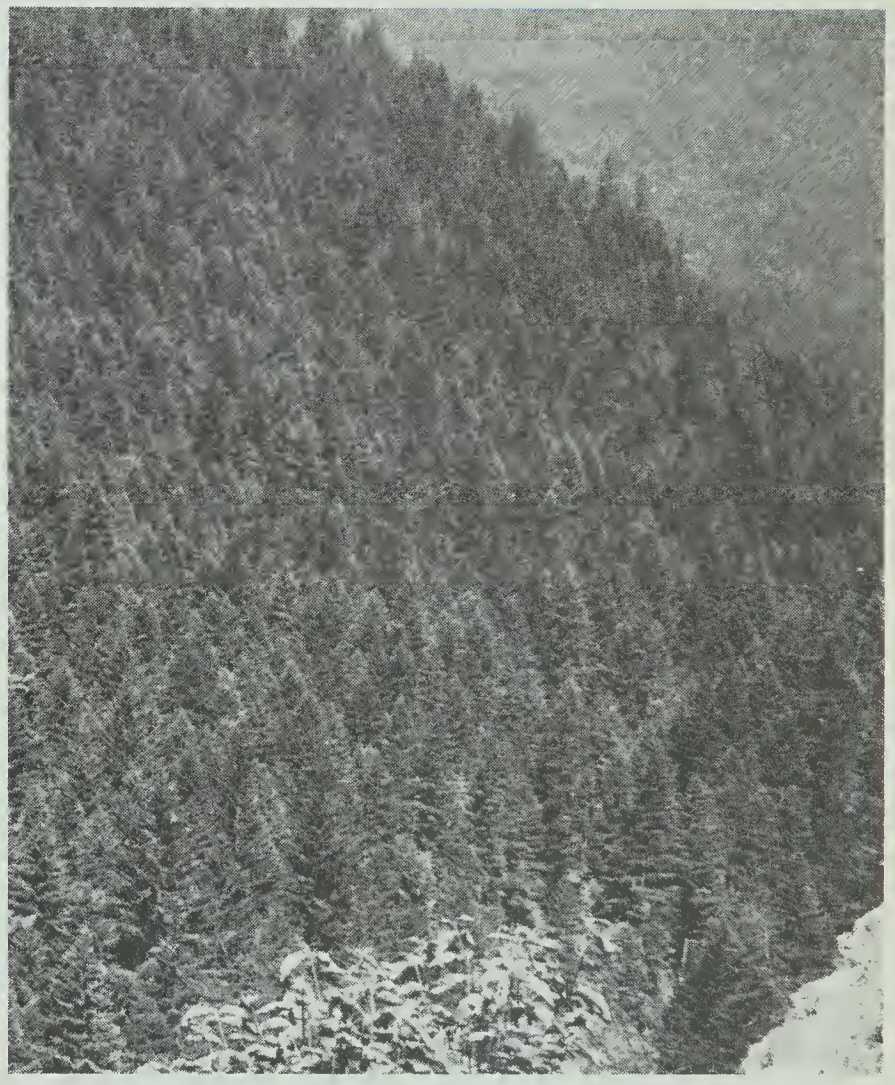


Figure 16-2

• 16-9. The desert bushes and cacti in Figure 16-1 above are in competition. What are they competing for?

16-9. For water, mainly, but also for minerals

• 16-10. The trees in Figure 16-2 above are also competing. What are they competing for?

16-10. For light, water, minerals, space, and perhaps air

• 16-11. Why do some plants benefit from being spaced well apart?

16-11. Competition for water, light, and other resources is reduced, and the plants can grow better.

ACTIVITY EMPHASIS: The reproductive cycle of the Ocala sand pine is dependent upon an important environmental factor — fire. Fire affects all Ocala sand pines at the same time, so they tend to grow in uniform stands.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

ACTIVITY 17: THE PINE TREE MYSTERY

If you like detective stories, you probably enjoy trying to solve the mystery before the detective does. Do the same thing in this activity. See how many clues you need to solve this plant mystery. The detective you'll compete with is a forest ranger assigned in July to the Ocala National Forest in central Florida. His name is Woody Woodworth.

One of Woody's assignments is to evaluate tree growth in the forest. On July 25, he spotted a mystery. He saw a stand of pine trees that was fairly dense. But there was something odd. All the trees in the stand were about the same size — about seven feet tall. None were much bigger or much smaller.

Strange! It looks like a plant nursery here with all these trees the same size. But I don't think this area has ever been logged or planted. What's going on?

As a good detective, Woody decided to make some observations and record his data. Then he would try to make sense out of the mystery. Figure 17-1 below shows a section from his notebook.

1. Mysterious stand of pine trees, all about 7 feet tall. Scrubby looking, poor form.
2. Needles are dark green, slender, double.
3. Cones on top part of tree in circular arrangement--lower cones gray, upper cones brown. Only a few cones open. Nearly all in tree and ground are closed.
4. Few grasses or weeds noticed--just some scrub oaks, rosemary, and saw palmetto.
5. Anthills scattered around. Evidence of small rodents, perhaps mice.
6. Soil very fine, sandy, seems very deep.
7. Temperature over 40°C near sand surface.
8. Seasonal weather: summers hot, winters mild and dry.
9. Rainfall average 135 cm per year (81 cm from June to September).

Figure 17-1

17-1. Polien from a male cone lands on a female cone. The pollinated female cone matures and opens up to release the mature seeds, which are formed on the scales of the cone.

• 17-1. How do pine trees reproduce? (If you don't know, refer to a biology textbook or an encyclopedia. Read the section on the reproduction of gymnosperms.)

• 17-2. What does the similar height of the trees suggest about their age?

17-2. They're probably all the same age. They probably germinated at the same time.

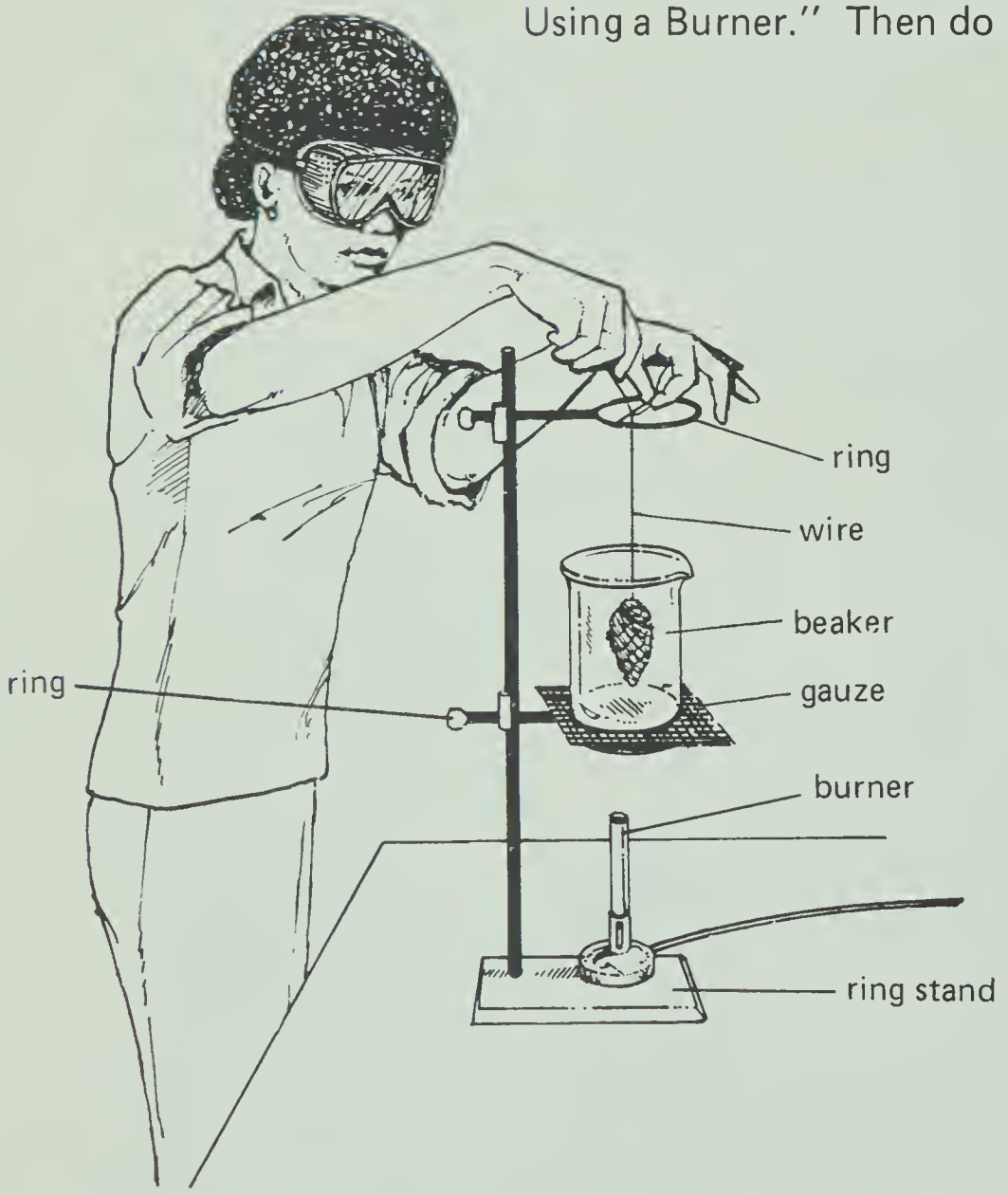
See "Advance Preparations" in the ATE front matter for a list of different types of pine cones that may be found in your local area.

A simplified, faster procedure will work with some types of pine cones. Put the cone directly into a beaker with no wires, and heat the beaker on a hot plate. The cone will open in 10 to 15 minutes.

Woody decided he needed to do a little laboratory work to check out his ideas about pine cones. You can do this investigation too. You'll need the following materials.

safety goggles
Ocala sand pine cone (closed)
ring stand and 2 rings
asbestos-wire gauze to fit ring
600-ml beaker
20 cm of bare copper wire
Bunsen burner
safety matches

If you're not sure how to use a burner, read "Resource Unit 17: Using a Burner." Then do Step A.



17-3. The cone started to open.

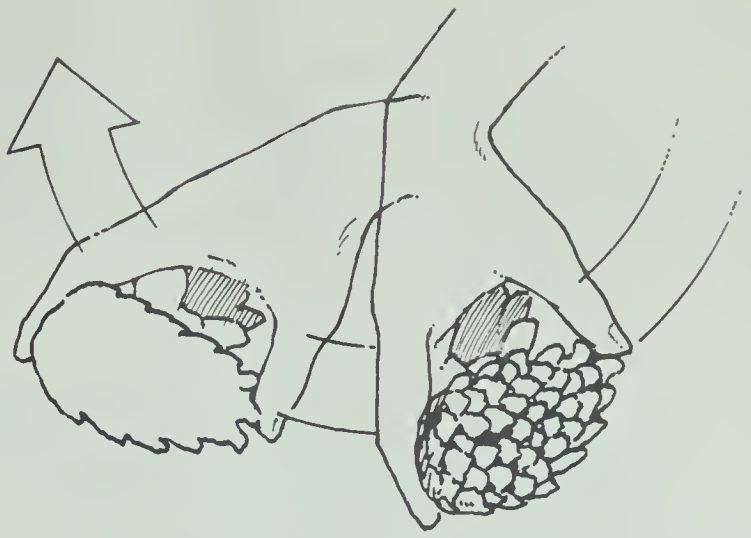
A. Set up the apparatus as shown. Tie the cone with the copper wire, and suspend it about halfway into the empty beaker.

B. Light the burner. Heat the beaker and pine cone for about 30 minutes. Observe the cone every 5 minutes or so.

● 17-3. What, if anything, happened to the cone while you were heating it?

C. Carefully take the pine cone out of the beaker. Shake it as shown.

D. Something should fall out of the cone when you shake it. Draw a sketch of the fallen object in your notebook.



● 17-4. Based on your investigation, name the factor in the tree's environment that could cause the cone to open.

17-4. Some source of great heat

● 17-5. Can you suggest a solution to the mystery now? If you can, do so. Then continue the activity to check your answer.

17-5. [Answers will vary. The correct solution is given in the answer to Question 17-9.]

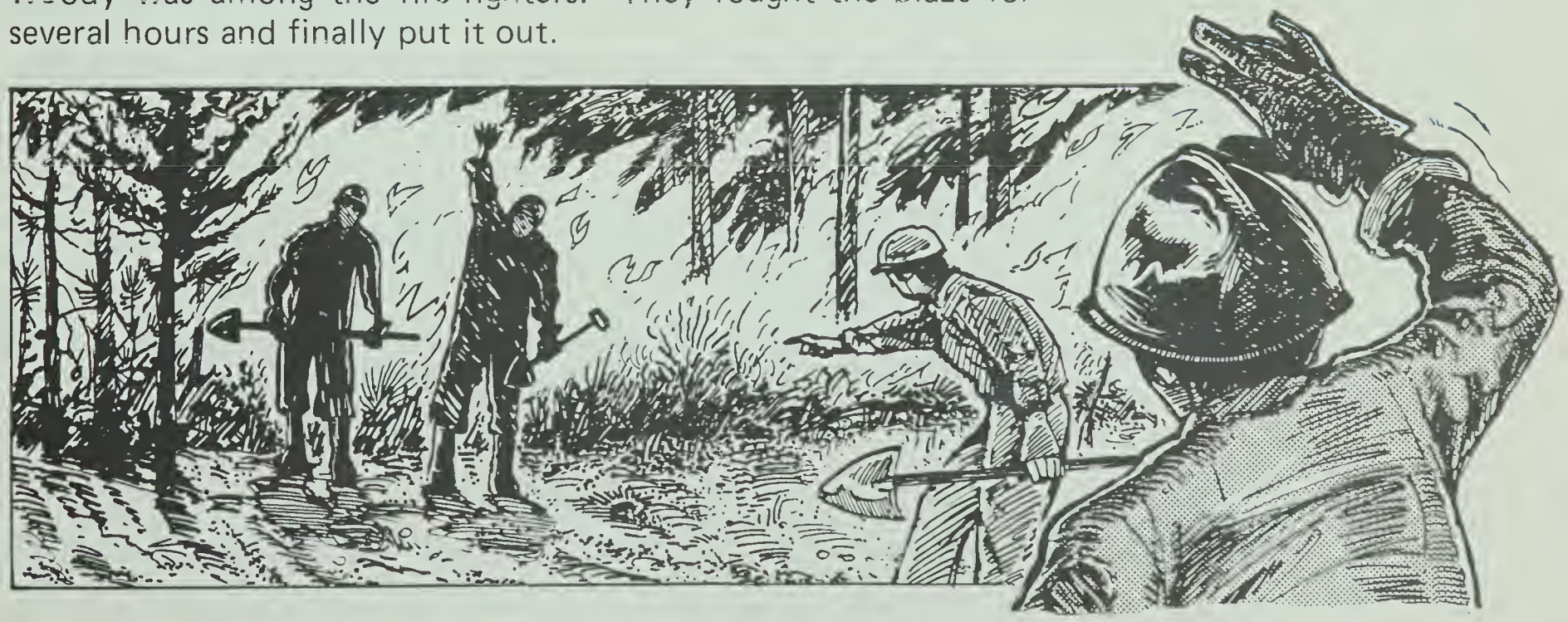
After doing his lab work, Woody decided to try a seed-trapping experiment. He wanted to learn how many seeds are released from different stands of the same kind of trees. First, he had to identify some more of these stands in nearby areas.

● 17-6. How would you identify more trees of the mystery variety?

17-6. Look for trees in similar environments with the same general form, bark, needles, and cones.

Having found some stands of trees, Woody set out his traps. These were metal boxes that he placed on the ground here and there among the trees. Woody noted the date in his notebook. It was July 27.

On August 15, early in the morning, there was a forest fire. Woody was among the fire fighters. They fought the blaze for several hours and finally put it out.

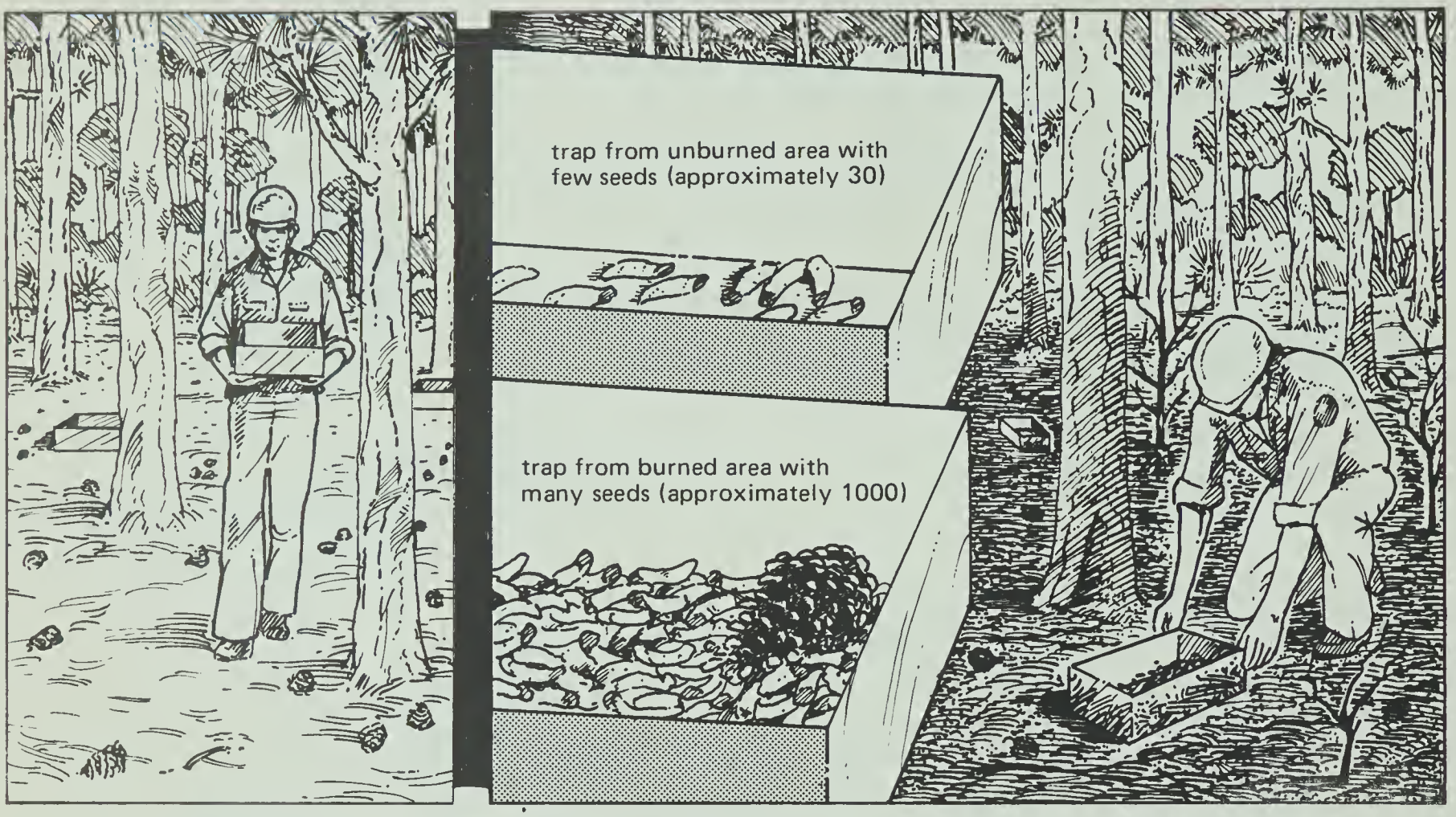


Woody helped clean the equipment and load it back into the truck. He noticed that the fire had burned through an area where he had set some of his seed traps. That was the lucky break he needed to solve the mystery.

17-7. The fire provided a source of great heat for the cones.

- 17-7. Why was that lucky?

It was August 25. Four weeks had passed since Woody set out the traps and ten days since the fire. Woody finally had a chance to go out and check the traps.



Woody felt very good. He had solved the mystery of the pine trees. Now see whether you've solved it, too. Answer the following questions.

17-8. The heat from the forest fire caused more cones to open and release seeds.

17-9. Fire provides great heat, which causes the cones to open and allows the seeds to be dispersed. Since all trees in an area are affected by a fire at the same time, all new trees will start growing about the same time and stay about the same height.

17-10. Check National Forest Service records, conduct a local library or newspaper office search, and interview people who have lived in the area for many years.

- 17-8. The traps from the burned area contained more seeds than the other traps. Why?

☆ **17-9. Typically, the Ocala sand pine grows in stands of trees all about the same size. Explain why this is, indicating how important fire is to the sand pine's reproduction and growth.**

- 17-10. Suppose you suspect that a pine stand is the result of a fire some years ago. How might you get data to support your hypothesis?

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